similar in principle to the last described, except that the taut wire in addition to giving a record of length is made to control the directive element too—that is, does the work of the telescope. The accuracy is thus self-contained, the instrument operator being required merely to take readings.

These two instruments find the true area, not an area bounded by straight lines. However, their weakness is that no graphical record of the section is made, and this is usually desirable and sometimes necessary.

The last type of instrument is one in which a graphical record is automatically obtained, also the true area of the cut or fill, without any computation whatever and without readings except final area. This instrument (Patent 1,174,649, March, 1916, John Airey and Karl F. Keeler) is shown in Fig. 3 (a model). Fig. 2 shows this same model in operation in the field, an ordinary stepladder being used as a stand.

The principle may be followed from Fig. 4. Here a tripod is seen standing on the roadbed in a cut. The instrument is shown disproportionately big for clearness. The maximum dimension of the instrument is 10 in.; its weight is less than that of a level. Two spools carry a roll of paper, the paper passing over a table. Thus the various cross-sections taken are kept in natural sequence on a continuous roll. The wire attached to the rod is unwound from the drum, in which there is a coil spring. Also the wire, passing through an eyelet in the arm, causes the latter to point at the rod. A pencil resting on the paper is swung around by the arm and at the same time is moved radially outward by the wire drum, so that it gives an exact reproduction of the cross-section of the embankment. The pencil also acts as the pointer of a planimeter from which the area is read off.

The closing side *CB* of the cross-section is completed by pressing a catch that disconnects the pencil and the planimeter from automatic control and by then drawing the line along a straight-edge laid against points *C* and *B* on the paper.

An important feature is the elimination of error due to varying sag of the wire, as the span of the wire varies. A small balance weight on the arm, Fig. 5, is automatically controlled so that the arm is always pointing true to the free end of the wire. The scheme employed, though simple, can be demonstrated to be theoretically perfect, and practical tests have failed to detect any deviation from correct alignment of the wire.

The foregoing discussion has reference to embankments or excavations already made. One of the chief uses of this instrument will be in the preliminary estimates of cuts and fills. The decreased expense with which this can be done will make estimates of alternative routes possible in a way that does not exist at present.

An outline of the possibilities in this kind of work is suggested in Fig. 6. It is required to set slope stakes and compute cut and fill for a canal whose center line has been located. The straight-lined contour is a celluloid templet cut to the shape of the finished canal and correctly positioned on the instrument table, which is done quickly by pressing the left side of the templet against a scale of elevations. An outline of the templet is then marked on the paper. The operator holding the rod traverses the ground line *ABC*, which the instrument reproduces on the paper. As the instrumentman observes this line cross the templet lines, he signals the positions where the stakes must be driven. The instrument operator now runs the pencil round the templet lines and reads the areas of cut and fill.

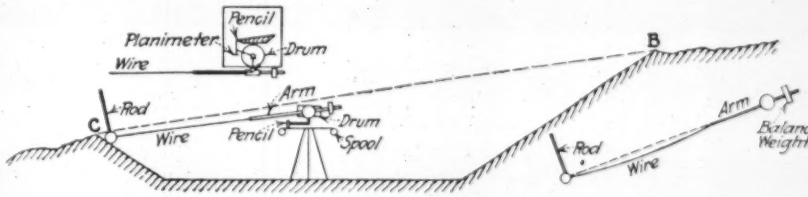


FIG. 4. DIAGRAM OF AIREY-KEELER CROSS-SECTIONER IN A RAILWAY CUT

FIG. 5. METHOD OF CORRECTING FOR SAG OF WIRE

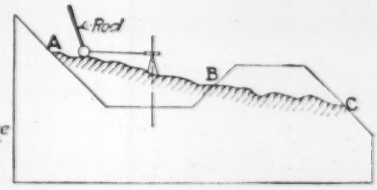
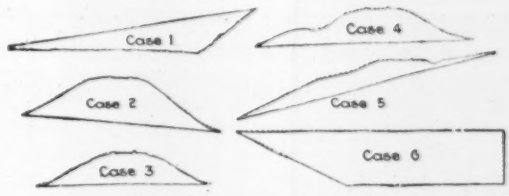


FIG. 6. HOW TO SET SLOPE STAKES

It is probable that various advantageous uses would develop in the course of practice for such an instrument in combination with templets. Some tests of the model to give a line on the convenience and workability of the scheme yielded the results shown in Fig. 7. There is good evidence to justify the belief that even this comparatively crude model is more accurate than rod-and-level methods (for example, notice that even the steel rails are evident in the diagram). With an instrument made by a reputable instrument maker, an accuracy of under 1% would easily be obtained.



	Cross-section Meter, First Reading, Sq.Ft.	Second Reading, Sq.Ft.	Planimeter, First Reading Sq.Ft.	Second Reading, Sq.Ft.	Maximum Difference, %	Minimum Difference, %
Case 1.....	278	283	279	279	1.4	0.36
Case 2.....	319	325	327	328	2.45	0.76
Case 3.....	205	209	202	204	3.25	1.97
Case 4.....	252	253	247	251	1.6	1.2
Case 5.....	200	195	198	200	2.0	0.5
Case 6.....	729	719	692	695	5.1	3.56

FIG. 7. COMPARISON OF AIREY INSTRUMENT AND ROD-AND-LEVEL RESULTS ON FOUR FILLS AND TWO CUTS

Dotted lines are plotted from level readings; full lines are drawn by instrument. Note how the instrument catches minor irregularities like the rails.

As to speed of work, the reader may form his own judgment of comparative times required in merely walking over the embankment at say 2 mi. per hr., then back to the instrument, compared with the time required by present methods to take the necessary number of shots in the field, then the subsequent plotting and planimetering.

This type of instrument will not handle all cases. The chief restriction in all the instruments using a wire is that the instrument must be so placed that a straight

line may be drawn in air from it to all parts of the contour—that is, the instrument must be able to see down the slopes. This restriction applies only in surveying embankments already built.

It is planned to use this instrument on a tripod whose two back legs have crosspieces like a stepladder; the instrumentman by standing 4 ft. above the ground would be in a convenient position to handle the instrument when high enough for a double-track fill.

Another limitation is that the contour must be such as can be traversed by the end of the wire. Precipitous cliffs are thus ruled out, or when the contour is very deep under water. Heavy brush might be troublesome and in extreme cases rule out the use of the instrument, but the fact that a zigzagging path to the extent of a few feet may be indulged in without error in reading will enable all but the extreme cases to be handled.

Finally, the limitation of magnitude arises. A big freight-yard would clearly be out of the scope of the instrument. The model shown has a 50-ft. wire, which means capacity to take a track nearly 100 ft. wide, or nearly all double-track roadbeds. A 75-ft. wire could just as easily be accommodated, which would amply suffice.

As roads of three and four tracks form a negligible proportion of the total mileage of the country (1.6%), there should be a big field for this instrument in appraisal work. New location—whether for railways, canals or highways—also offers large opportunities. Indeed, highway location is probably the most important field of all. There is every evidence that the great development in improving means of transportation will in the next decade be in the construction and improvement of highways.

Considering the above fields of employment, and remembering that 5 men (3 field men and 2 computers) are replaced by 2; also that these two make greater speed and increased accuracy, the writer refrains from attempting an estimate of the saving effected, as it might seem rash.

Measuring Yardage of Granite Blocks by Weight

To arrive at a new basis for settling with the producer for shipments of granite blocks in carload lots, weights and counts of 19 carloads were recently made under the direction of Charles H. Clark, Engineer of Maintenance-of-Way, Cleveland Railway Co., Cleveland, Ohio. Mr. Clark states that the only right way to purchase granite blocks is by the thousand, but that they are more often bought by the square yard.

The specifications generally stipulate that there shall be a certain number of blocks per square yard and that a test of each carload shall be made. In such test there is always chance for an error on one side or the other, and after a number of carloads have been thrown into a common pile there is no way of making a recount to settle differences between the shipper and purchaser. With a freight rate of $2.58 per ton, and also taking into account the cost of the blocks themselves, a difference of 5 or 10 yd. per car mounts up in the course of a season.

The plan followed by Mr. Clark was to determine the weight of blocks in each carload, then fill an 8-yd. frame with blocks, count the number of blocks, and find their weight. It was found that for 18 of the 19 carloads (marked weight being taken for one carload for tare) the corrected weights of the cars themselves were less than the marked rates in 16 instances, the excess or basis of overcharge running as high as 4,100 lb. in one case, 2,000 in another, and on down to a few pounds. For two cars only was the corrected weight in favor of the shipper. The number of blocks in an 8-yd. frame ranged from 240 in two cases, with weights of 4,400 and 4,150 lb. per frame, to 218 blocks in one frame weighing a total of 4,280 lb.

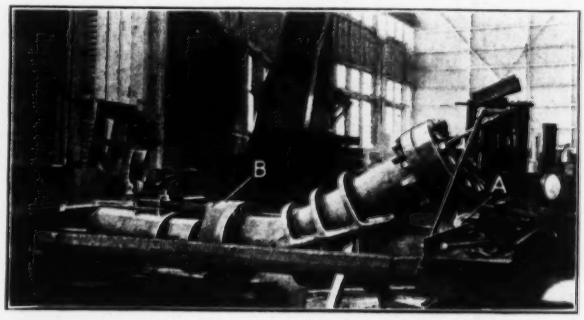
A weight of 535 lb. per sq.yd. of granite blocks was established as the result of the tests, as compared with 26 blocks per sq.yd., or a weight of about 485 to 500 lb., according to the shipper's claim.

The specifications under which the paving blocks were bought by the Cleveland Railway Co. for paving work between tracks called for blocks with lengths of 8 to 12 in., widths not less than 4 in. nor more than 5 in. and depths not less than 5 nor more than 5½ in.

High-Pressure Test of Pipe with Unbolted Flanges

By J. W. Swaren*

Seventy-three cast-steel branches were required for station connections in an oil pipe line recently built in California. These branches were tested to 2,000 lb. pressure for twenty minutes in the shop of the Pelton Water Wheel Co. The method of performing these tests was unique.



HOLDING OIL-PIPE SPECIALS IN PRESS WHILE TESTING

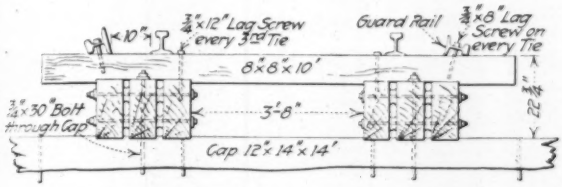
A hydraulic jack which is ordinarily used in field work for pressing on flywheels and rotors was blocked up in a framework made of structural shapes. A blank flange was rested against the head of this framework, as shown at *A* in the photograph; another blank flange shown at *B* was rested against the head of the jack. A third blank flange was bolted to the branch flange of the pipe section, and the latter was picked up by a crane and put in place between the two blank flanges in the frame, with a piece of stencil-board as gasket. Applying 500 lb. pressure to the jack, the two unbolted end flanges were held on tight enough to resist the thrust due to the test pressure inside the pipe.

The sections have a bore of 8 in. and weigh 1,250 lb. each. The testing was done by two helpers under the direction of an inspector, at the rate of 10 sections per day. The 73 branches were supplied by the Best Steel Casting Co., and not a single one proved defective during the test. These tests were made after all machine work had been completed.

*Hayward, Calif.; R.R. 2, Box R.

Bridge Floor with Old Rails for Outside Guards

Steel guard rails for bridge floors, placed outside the track rails and used instead of the usual outside guard timbers, are standard practice for bridges and trestles on the Atlanta & West Point R.R. and the Western Ry. of Alabama. Old rails are used, laid on their sides, with the base 10 in. clear from the base of track rails, as



OLD-RAIL GUARD ON BRIDGES OF ATLANTA & WEST POINT R.R.

shown in the drawing. At the ends of the bridge the guard rails are flared away from the track. Each guard rail is fastened to every tie by a ¾-in. lagscrew 8 in. long. No inside guard rails are used. This construction has been followed for some years with satisfactory results, and in cases of derailed trucks it has guided them safely across the structure. Information has been furnished by O. T. Nelson, Superintendent of Maintenance-of-Way, Atlanta, Ga.

Large Reinforced-Concrete Mat Building-Foundation

A mat foundation is to be used under rather unusual conditions in the case of a factory and warehouse building to be constructed for Wyman, Partridge & Co. in Minneapolis, Minn. The building is to be a 12-story structure of reinforced concrete, 108x162 ft. in plan. The column spacing is arranged to give large bays—19 ft. 10 in. by 26 ft. 2 in.—and the loading is fairly heavy. Kees & Colburn are the architects.

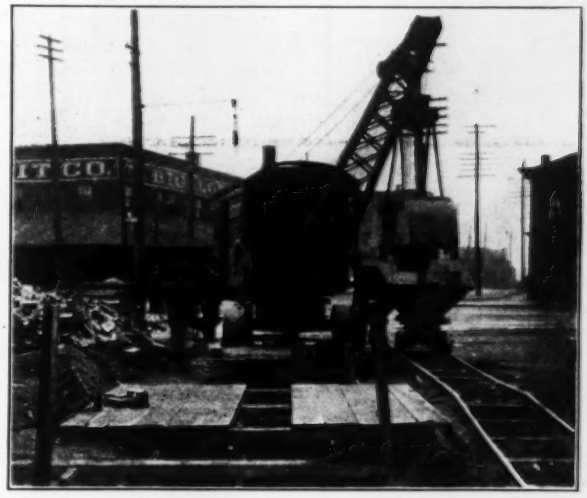
Soundings to a depth of 100 ft. failed to strike rock, an unexpected condition. The soil encountered was clay with loam and a very fine, unstable sand. A preliminary design for spread footings resting in this soil showed that a footing would be almost as large as a bay and would be of considerable depth. It was then decided that the footings should be made continuous, as by such construction also the necessity of keeping the foundations within the property line could be provided for without cantilevering for the support of the outside walls.

In accordance with this decision a full slab or mat 108x162 ft., 5 ft. in thickness under the outside walls and 4 ft. in thickness under the interior, and with four-way reinforcement both top and bottom, was designed. On this mat rest stepped pedestals 12 ft. square by 2 ft. thick and 5½ ft. square by 2 ft. thick, supporting the column bases.

The building columns are in general of reinforced concrete, but in the lower seven stories space is saved by making them of steel sections incased in concrete. A heavy basement column consists of four 6x6x⅞-in. angles, six web plates 13x⅞ in., six flange plates 20x¾ in., and two flange plates 20x⅝ in.

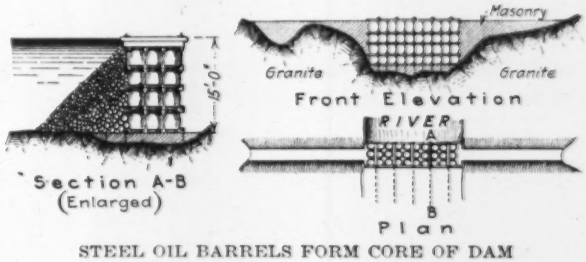
NOTES

A Steam Shovel with Grab Bucket is digging a sewer trench 21 ft. deep in Cleveland, Ohio. A 3x5-ft. brick sewer, with 16 ft. of cover, is being built, the excavation being accomplished by an Osgood 18 equipped with a special boom and an Owen grab bucket. The muck is carried away by a Lakewood car, as shown in the view which was taken at the junction of East 9th St. and Orange Ave. The plant has several interesting features—one is its compactness, and another is the small amount of manual labor required. Bricklayers can follow close behind the excavation, and the backfill must be transported only a short distance before dumping. In addition to the economical aspect of this method only a short stretch of street is obstructed. The work is carried on in sand, and sheeting is set as needed. The head of the trench is sheeted, as the view shows. William McDowell is the contractor.



STEAM SHOVEL WITH GRAB BUCKET DIGGING A 21-FT. SEWER IN CLEVELAND, OHIO

A Dam Made of Oil Barrels has been built in northern Nigeria to help form a dredging pool used in mining operations. The dam is 15 ft. high and is formed of 120 of the steel barrels in which oil fuel is brought to the site. Other suitable dam materials are very scarce. The barrels are arranged as shown in the sketch and are filled with sand to give weight. They are tied together with timber plates, filled in between with broken granite and tied back upstream with slanting steel tie-rods. The upstream side of the dam is backed with broken rock, the filling being graduated in size from coarse rock next the barrels to fine rock and finally sand and earth. The dam is described in a paper before the Institution of Mining and Metallurgy, by H. E. Nicholls.

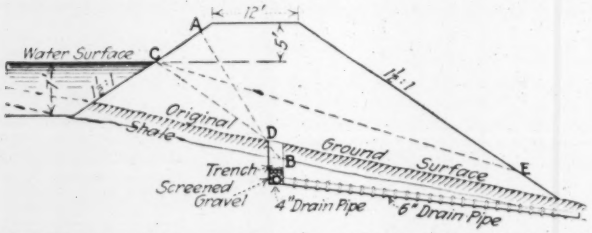


STEEL OIL BARRELS FORM CORE OF DAM

Scrapping Old Iron Bridge—The Cumberland Valley R.R. several months ago sold to a local junkman the old Potomac River Bridge, the seven spans of which were replaced by plate girders on concrete piers about 1½ yr. ago. The old trusses, built by the Union Bridge Co., in 1889, were about 150 ft. long each and placed 50 ft. above low water. When the bridge was demolished, the water in the river was from 4 to 10 ft. deep. Wreckers cut up the floor system with flame

and threw the trusses into the river, from which they were later fished up and burned to sizes convenient for handling with a small roughly built derrick. Practically the only plant employed consisted of this derrick, a hoisting engine and a push car. The wrecking was done without falsework. Under favorable conditions six men were able to take down a span per week and load it for temporary disposal. River conditions, however, were such that the work proceeded on half time only.

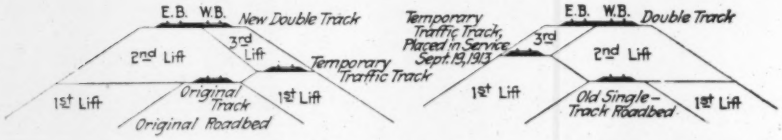
Tile Drainage for Canal Embankments on sidehill location has been introduced to a considerable extent on the Grand Valley Project of the United States Reclamation Service in Colorado. The accompanying illustration shows a typical installation on the main canal, Divisions 3 and 4 of the project.



SYSTEM OF TILE DRAINAGE FOR IRRIGATION-CANAL EMBANKMENTS ON SIDE HILLS

The line CE indicates the probable location of the upper surface of the saturated portion of the embankment, if no underdrainage is provided. With an embankment on a sidehill slope like this, settlement and sliding are apt to occur, along some plane as AB. The tile subdrainage is expected to lower the plane of saturation to CD, keeping the toe dry and preventing sliding or sloughing. A longitudinal drain is laid a little downhill of the center line of the embankment location, of 4-in. vitrified clay pipe laid on 0.01 slope or greater, at a depth of 2 to 3 ft. below ground and surrounded by 12 in. of screened gravel. At intervals this longitudinal tile is drained by a transverse 6-in. tile laid with tight joints. On this project the total length of these drains was 3,184 lin.ft., and the total cost, including excavation, screened gravel and pipe, was 37c. per lin.ft. The work was done under the direct supervision of Fred J. Barnes, Assistant Engineer. J. H. Miner is Project Manager.

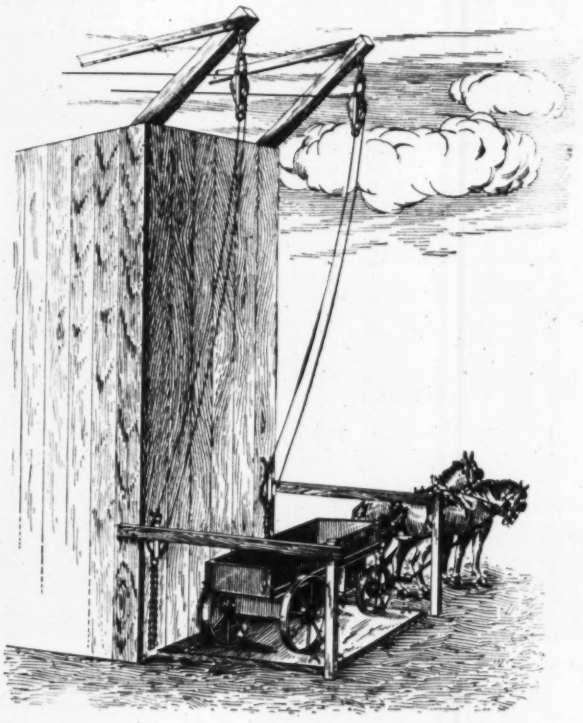
Raising the Embankment Approach to the Atchison, Topeka & Santa Fe Ry. bridge over the Missouri River above Kansas City, known as the Sibley bridge, was accomplished without interruption to traffic by the method shown in the right-hand sketch. The grade of the approach was reduced from



(LEFT) PROPOSED AND (RIGHT) ACTUAL METHOD OF RAISING FILL OF SIBLEY BRIDGE APPROACH, SANTA FE RY.

0.8% to 0.5%, the total height of fill added being 11 ft. Besides, the embankment was widened for two tracks. The changes were completed late in 1915. On account of a continued dry spell in 1913, while the work was in progress, the lift was made in two stages, as shown at the right, instead of in three stages, as proposed originally. R. A. Rutledge is Chief Engineer of the Eastern Lines of the Santa Fe and G. J. Bell, now District Engineer at Newton, Kan., was engineer in charge of the work described.

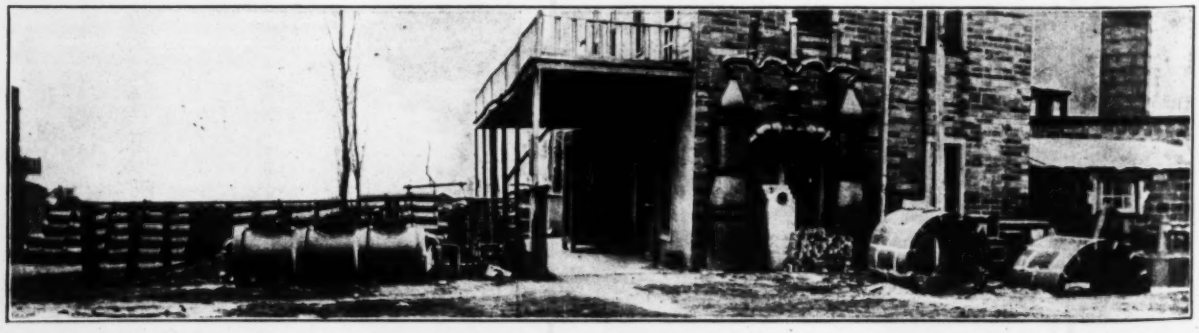
Putting Sand in High Bins of the concrete plants at the new Plankinton Hotel now under construction in Milwaukee, Wis., requires that the material be elevated about 40 ft. This is accomplished by the platform lift shown in the



A SAND-HOISTING PLATFORM IN MILWAUKEE

sketch. The sand is delivered on the elevator by wagons. It is dumped, the wagon is driven off, the hoisting hooks (three to each end) are attached, and the elevator is raised until one edge contacts with the lower part of the hoist beams. The platform pivots about this edge until stopped by the beams, the sand sliding off into the bin. This loading scheme is used at both of the concrete plants on this job. The contractors are W. J. Hoy & Co., of St. Paul.

A Permanent Exhibit of Clay Products—The office of the San Antonio Sewer Pipe Works, about 30 mi. south of San Antonio, Tex., is arranged as a permanent exhibit of clay products. In the left-hand foreground of the view herewith is a clay-pipe septic tank. To the right are sewer-pipe specials—reducers, bends, elbows, etc. Below are chimney flues, and in the foreground are segmental-block sewers. The semicircular arch on the right rests on an invert interlocking flat block. All the buildings of the plant are constructed of hollow tiles.



PERMANENT EXHIBIT OF CLAY PRODUCTS, SAN ANTONIO SEWER PIPE WORKS, TEXAS

Editorials

Highway Foundations and Motor Trucks

It may be said without fear of contradiction that there is no state in the Union where the state highway work has been more thoroughly and scientifically done than in Massachusetts. Not only was Massachusetts the first state to embark on a large scale on highway construction with state appropriations, but the engineers who gained their experience in highway work there in the early days have been the leaders in good road construction in many other states.

It is of especial interest, therefore, to learn that the damage done to Massachusetts state highways during the past winter by motor trucks and motor omnibuses is far in excess of anything ever before experienced there. According to information from Col. William B. Sohier, Chairman of the Massachusetts Highway Commission, the worst damage occurred in January, when a long continued thaw drew the frost out of the ground, leaving it very soft. At this time a great many miles of the oldest state highways were broken through by motor trucks. The vehicles actually went through the road crust and sank up to their hubs. Some of the older state roads which hitherto always had carried traffic satisfactorily and been kept in good condition by oiling were so badly cut up that they looked like plowed fields.

Most of the macadam roads that thus suffered were waterbound macadam roads 12 to 24 years old and in most cases without a telford foundation. When Massachusetts first began state road building, the traffic was generally light and where the roadway was of sand or gravel it was not generally deemed necessary to use a telford foundation. Many of these roads have been kept in good condition for traffic by patching and oiling but have never been resurfaced with additional stone to make up for the wear. It is evident that they were worn too thin to stand the load upon them under the conditions stated.

What to do in the situation is a difficult problem. Massachusetts has built about 1,100 mi. of state highways. Several hundred miles of the older main routes undoubtedly should be resurfaced with at least 3 in. of stone to give them the requisite thickness to stand heavy traffic. The appropriations available for this work, however, are sufficient to widen and resurface only about 70 mi. a year, which probably does not keep pace with the wear and tear that is taking place.

The matter is of especial interest at this time when states, counties, and probably the Federal government are about to invest a larger amount of money in good road construction than ever before. The responsibility lies upon engineers to say how these roads shall be built and what foundations shall be provided for them. As has been recently pointed out in these columns, it is well nigh impossible to say what foundation conditions ought to be established without knowing what weights of vehicles are to run over them and at what speeds. The motor-truck enthusiasts are fond of declaring that it is the business of the public to build roads capable of carrying a vehicle of any weight, at any speed. The engineer, however, is faced with the difficulty of making a limited appropriation cover a certain number of miles. This appropriation, moreover, in many cases is borrowed money which a future generation must pay; and unless the foundations of the road are made secure, the road is likely to be destroyed long before the debt comes due.

In view of the damage done to the macadam roads of Massachusetts this spring, Colonel Sohier is of the opinion that it may become necessary to substitute some form of permanent pavement in place of macadam even on the country highways.

Scientific Explanation Is Not Invention

An interesting decision has recently been rendered by the United States Circuit Court of Appeals for the Second Circuit in a suit for the infringement of a patent on waterproofing paint. It is a well-known principle of patent law that an inventor's right to a valid patent is not barred because he does not fully understand or does not fully explain in his specifications the scientific principles on which his invention is based. In the case just decided the court laid down the further principle that in order to invalidate a patent on an invention it is not necessary that an earlier inventor who made the same invention and secured the same results should understand the scientific principle on which he was working.

The suit in question was one brought by Henry M. Toch and Maximilian Toch against the Zibell Damp-Resisting Paint Co. The case was decided in favor of the defendant by the Court of Appeals on Feb. 21, 1916, but the plaintiffs were granted a rehearing. The court has now reaffirmed its original decision.

The court based its original decision in favor of the defendant on its belief that the defendant had made public use of the invention more than two years prior to the date of the plaintiff's patent application. In petitioning for a rehearing the plaintiff's attorneys set up the claim that use without knowledge does not make a patent void. In other words, that even if Zibell accidentally and without intention produced a paint which had the same effect that was afterward obtained by Toch's preparation, it should not be a bar to the validity of Toch's patent, since Toch for the first time revealed to the public in his patent the scientific basis on which such paints could be fabricated and produced with certain knowledge as to their results.

The case of prior public use which was relied upon by the defense was the painting of the masonry walls of an underground squash court on the Blair country estate at Peapack, N. J. The court in its decision describes the use of the Zibell paint on these walls and then lays down the principle previously referred to, as follows:

Various attempts had been made to paint these walls and all of them proved unsatisfactory, as it had been found impossible to make any of the paint which they could get hold of stick on the walls. In the spring of 1903 the civil engineer in charge of all Mr. Blair's construction work noticed in "Engineering News" an advertisement of Zibell's product which in effect stated that the Zibell Damp-Resisting Paint Co. could furnish paints in various colors which would be guaranteed to resist dampness when applied to walls. Thereupon he obtained several gallons of a material known as Protectorine and applied the same to the wall with results which were entirely satisfactory, the original paint being still on the walls at the time of the trial of this case.

As it is not necessary in order to sustain a patent that the inventor should understand the scientific principle which underlies his invention, it is also not necessary in order to invalidate the patent to show that one who made use of the same process to accomplish the same result prior to the patent understood the scientific principle.

The Bell telephone transmits speech by transmitting it by means of electricity. But precisely how electricity operates under Bell's process or what form it takes, neither Bell nor anyone else knows. But that fact did not affect his right to obtain his patent. [Telephone Cases; 126 United States, 1 (1887).] The scientific principle is no part of the process for which a patent is granted and does not need to be set forth. [Emerson vs. Nimocks; 99 Federal, 737 (1900). Eames vs. Andrews; 122 United States, 30 (1886).]

Toch may understand better than Zibell the scientific principle involved in the process. He states in his specification:

The acid filler above described reacts with the calcium compounds in the outer portion of the cement construction to form a hard resinate or other organic calcium salt, which serves as an efficient protective layer and which is reinforced by the second or exterior coating.

And there is much in the brief submitted by his counsel on the chemical effect of the Toch mixture on a portland-cement construction. But chemical reactions as such are not patentable as a process.

We do not think that the fact that Zibell did not tell the public how to make Protectorine, as he would have had to do if he had applied for a patent, but kept its composition secret, precludes him now from defending a suit for the infringement of a patent, taken out subsequently for a like process accomplishing a like result.

The Increase in the Corps of Engineer Officers

The present authorized strength of the Corps of Engineer officers of the U. S. Army is 248. The army reorganization bill, signed by the President, June 3, provides for an increase in the number of officers of the Corps of Engineers to 505. The following table shows the number of officers authorized in each grade under the present organization and under the new organization:

COMMISSIONED OFFICERS OF THE CORPS OF ENGINEERS

Present Organization	New Organization
1 Brigadier-General (Chief of Engineers)	1 Brigadier-General (Chief of Engineers)
15 Colonels	23 Colonels
22 Lieutenant-Colonels	30 Lieutenant-Colonels
51 Majors	72 Majors
60 Captains	152 Captains
56 First Lieutenants	148 First Lieutenants
43 Second Lieutenants	79 Second Lieutenants

The enlisted engineer troops are to be proportionately increased as follows: Under the present army organization the enlisted force of the Corps of Engineers consists of three battalions. Under the new law the engineer troops are to include seven regiments and two mounted battalions, and as each regiment is made up of two battalions, there will be sixteen battalions in place of the three authorized by the old law. Under the new law, however, each battalion is to consist of three companies, whereas under the old law there were four companies to each battalion. It will be evident that the increase in the number of engineer-officers is necessary to provide for the increase in the engineer troops.

The increase which the act provides for is to be made in five annual increments as nearly equal as possible. It will of course be necessary in order to obtain the number of officers required for the largely increased army, that a large number of men from other sources than West Point must be given commissions. The act provides that vacancies in the grade of Second Lieutenant in any fiscal year are to be filled by appointment in the following order: (1) Graduates of West Point; (2) enlisted men, whose fitness for promotion is to be determined by a competitive examination under existing law; (3) members of officers of the reserve corps between the ages of 21 and 27; (4) commissioned officers of the National Guard between the ages of 21 and 27; (5) such honor graduates of distinguished colleges between the ages of 21 and 27 as may be entitled to preference by general orders of the War Department; (6) candidates from civil life between the ages of 21 and 27.

The act further provides that appointments to the grade of Second Lieutenant in the Corps of Engineers shall continue to be made as now provided by law. Officers of the Army and Navy, however, may become candidates for appointment as Second Lieutenant of Engineers under the provisions of a law of 1911 without previously vacating their commissions as officers. A further important provision is that the Secretary of War may, in his discretion, allow persons to become candidates for the Second Lieutenancy without previously establishing their eligibility for appointment as a Junior Engineer under the Engineer Bureau of the War Department.

Notwithstanding all that has been said in the past two years concerning the need of an increase in the number of army officers and especially of Engineers, there are fourteen vacancies in the Second Lieutenancies provided for by the old law and two vacancies in the list of First Lieutenancies. The figures in the table show that to comply with the new law there must be for the next five years 51 more appointments to the Corps of Engineers annually than have been made under the present law.

That the method hitherto in force for the examination of candidates for admission to the Corps of Engineers has been such as to prevent the increase in the corps which is authorized by law and which has long been demanded by the conditions of the service, is obvious from the vacancies now existing. It is beyond question, therefore, that a radical alteration in the requirements for admission to the corps must be worked out and put in force in order to comply with the new law.

"The Cohesive Power of Public Plunder"

The River and Harbor Bill, which passed the House on Apr. 11, carrying appropriations of about $40,000,000, was passed by the Senate on May 29, with amendments increasing the total appropriations to nearly $44,000,000. On its final passage the vote was 35 in favor of the bill to 32 opposed, with 29 senators not voting. The narrow margin by which the bill was finally passed indicates the formidable opposition that was encountered in the Senate.

A remarkable feature of the debate was the frank admission by a number of the senators who favored and voted for the bill that many of the items it contained were unjustifiable and a waste of public funds. For example, Senator Clarke of Arkansas, the chairman of

the Senate Committee on Commerce, which prepared and had charge of the Senate bill, said:

> There comes to be a kind of rivalry between boards of trade in local communities to have the same wasteful expenditure of public money made within the particular zone of their influence as takes place elsewhere. In the beginning this manifested itself as a demand upon the individual members of Congress. This system of selection proceeded to a point of demoralization, where the resulting bill was known as a pork-barrel bill.
>
> To protect the treasury against that character of assault, the method of submitting all projects to the scrutiny of a board of engineers was invented and has progressed until the present day. It has eventuated in the approval of projects involving appropriations of the $43,000,000 contained in this bill, plus about $150,000,000 more of approved projects ready to go into some other bill. My experience in the last 12 years has satisfied me that this method has broken down just about as badly as the other and that the time has now arrived when a move forward must be made and other plans of national defense of the treasury supplied. We have reached a place in this river and harbor business, if the thing keeps up at the pace at which it is now going, when there will be a revulsion of sentiment in this country that will stop the whole business.

Closely parallel to this statement by Chairman Clarke were the remarks of Senator Smoot of Utah, who said:

> This bill carries appropriations of over $43,000,000. I state without hesitation that at least 33⅓% of them ought to be eliminated from the bill. I will say frankly that I have given more attention to river and harbor bills during the last three years than in all of my previous service in the Senate. I always felt and feel now that there ought to be liberal appropriations for the improvement of our rivers and harbors, but what I object to is projects in the bill which I believe no one can justly defend. This is the last river and harbor bill made in the form in which this bill is framed that will pass Congress.

Senator Kenyon of Iowa led the fight against the bill and in the concluding speech of the debate said:

> This Senate is about to pass a bill which few senators had the temerity to defend. You are appropriating hundreds of thousands of dollars for streams where Congress has ordered the reëxamination and no report has as yet been filed by the engineers. You are dumping hundreds of thousands of dollars into streams where commerce is constantly growing less and in some cases is practically nothing. You are making appropriations for streams not over 1 ft. in depth. You are appropriating for others where the testimony before the House committee was that you could not tell when you crossed the river. You are appropriating hundreds of thousands of dollars for projects which the army engineers have condemned. You are about to vote from the treasury, in a time of great national stress and strain, at least $20,000,000 in unjustifiable projects. A fight against this method of appropriating public money is going on. I risk the prophecy that this is the last river and harbor bill framed along the lines of the present bill that will ever pass Congress. Some day a Congress will be here that will not consider those the greatest statesmen who get the most out of the national treasury. Some day a Congress will think along national lines and not state and district lines, and that day is coming just as certainly as tomorrow's sun will rise.

The foregoing quotations are typical of the debate that has been going on in the Senate for over a month. There was of course the usual hackneyed defense of water transportation and the usual display of senatorial courtesy in tacit recognition that a senator from a state is bound to defend and work for appropriations for his state, whether they are good or bad. It was clear, however, that at least three-quarters of the senators fully understand the inherent corruption in the present method of making up river and harbor bills and would gladly welcome some method of framing such bills that would place the interests of commerce and navigation first and relieve members of Congress of the present responsibility for drawing all the money they can from the national treasury to be spent among their own constituents.

One of the most interesting features of the debate on the bill was the offer of several amendments looking to some better method of distributing Federal appropriations for the benefit of navigation. Senator Shafroth of Colorado offered an amendment:

> That each of the appropriations contained in this bill shall become available only in the event that states, counties, cities or individuals shall pay into the treasury as part of the same 20% of the amount thereof.

There was hearty approval of the principle embodied in this amendment. It was in fact recommended in the report of the National Waterways Commission some years ago. In the form presented, however, there was general agreement that it would be difficult of application, one reason being that the local benefits from a harbor improvement, for example, may be spread over such an extended territory that it would be impossible justly to assess a contribution on those helped.

Senator Newlands of Nevada offered an amendment incorporating his well-known scheme for a national river-regulation commission to be placed in control of everything in connection with the flow of streams, from irrigation and municipal water-supply to water power and navigation. This amendment was accepted by Chairman Clarke for the committee in charge of the bill, but was later struck out on a point of order. A much more practical scheme was embodied in an amendment offered by Senator Kenyon of Iowa, which provided for the creation of a permanent national waterway commission of five members whose duty it would be to investigate the entire subject of Federal waterway improvements and report to Congress upon the merits of each project. This amendment was also struck out on a point of order.

The same disposition was made of an amendment to create "an inspector of river and harbor work who should be a trained and experienced civil egineer, not connected in any way with the army." This inspector was to examine thoroughly all the river and harbor projects adopted by Congress, ascertain whether the money was being expended with the best economy and efficiency, and also to what extent the needs of commerce justified the expenditure. This inspector was to receive a salary of $7,000 a year and was expected apparently by his individual exertions to make a detailed investigation of each and all the river and harbor projects throughout the length and breadth of the United States. It was quite as well that this amendment failed.

It should be emphasized that the senators who led the fight against the bill almost without exception emphasized, as did Senator Smoot in the quotation already given, their approval of works to aid navigation where the expenditure is justified by the actual benefit to commerce. Very likely a sum as great as the entire appropriation carried by the present bill could be profitably expended in the next fiscal year on work for navigation improvement, provided it were concentrated on meritorious works and not distributed over the country in order to give a due share to each influential congressman.

As Chairman Clarke himself pointed out in the remarks previously quoted, it is only too evident that reliance on the army engineers as a check upon national extravagance and wastefulness in waterway improvement has all but broken down. It is too much to expect that the engineer officer in charge of a district will always be brave enough and strong enough to stand up single-handed and alone and oppose the demand of the commercial organizations in the locality for a big slice of

money from the national treasury. Even if he has the courage to do it, the local organizations and local newspapers may neutralize his efforts.

Colonel Deakyne's report on the Missouri River improvement, when he was stationed at Kansas City, is an excellent illustration. Colonel Deakyne, in the discharge of his duty as an able and conscientious engineer, reported that the proposed expenditure of $20,000,000 by the Federal treasury in an attempt to revive navigation on the Missouri River from Kansas City to its mouth was an unjustifiable expenditure of public funds. It is difficult to see how any competent engineer thoroughly familiar with that river, with transportation conditions in that locality and with the history of river transportation on Western rivers during the last two decades could have made any other report.

The result of this conscientious discharge of his duty, however, was a social and business boycott of Colonel Deakyne, which eventually compelled his transfer to another station. It may be mentioned in passing that a notable feature of the Senate debate was the splendid defense of Colonel Deakyne made by Senator Husting of Wisconsin in connection with one of the ablest arguments ever heard in Congress against the present system of spending Federal funds for the benefit of local land and business interests.

We call attention to the case of Colonel Deakyne, however, because it is not exceptional, but typical. Officers of the Engineer Corps have a high reputation for honesty and ability; but they are after all only men, and it is too much to expect that alone and single-handed they will be able successfully to oppose an overwhelming current of local public sentiment in favor of Federal appropriations for their district. It is not at all strange that the young captains and majors in the corps, in view of the experiences of Colonel Deakyne and others, should feel that it is practically useless for them to oppose their individual opinions against the popular sentiment of the business community in which they live and work.

It is doubtful if any body of engineers would be able successfully to combat the influences that work to secure these appropriations. It is of little avail to prove that an appropriation will be of no real benefit to navigation when the parties who are working for the appropriation do not really care two pins for navigation and are merely desirous of securing the expenditure of money from the Federal treasury to benefit private landowners and other interests.

The most promising plan of reform appears to be through the development of some workable system whereby those who clamor for Federal funds for a river and harbor project will have to pay a material part of the cost themselves.

Coupled with this should be the creation of a permanent national commission, clothed with some such broad powers as those granted the Interstate Commerce Commission, with authority to supervise all Federal works for navigation improvement. Such a commission should be composed of men of such standing with the public that Congress would not dare to override its recommendations as to the distribution of public funds.

Letters to the Editor

"Spouting" or "Chuting"?

Sir—The use of the two words "spouting" and "chuting" as synonymous terms in your abstract of the committee report on spouted concrete, presented at the National Conference on Concrete Roads (*Engineering News*, Apr. 27, 1916, p. 802), suggests that a distinction between these terms is very desirable.

The report deals with the discharge of concrete directly from the mixer into a short chute leading to the form or the surface of the road. This process appears to be well covered by the term "chuting." The term "spouting" is more generally applied to the use of long spouts extending from elevator towers in which the concrete is hoisted by buckets to the head of the spout.

The angle of slope, consistency of concrete and other conditions would be very different for the two methods, and it would be convenient if the distinction of terms could be generally adopted. SPOUTER.

Chicago, June 1, 1916.

[While the distinction noted by our correspondent may be desirable, it can hardly be called common. The processes noted may indeed be quite distinct and should properly be distinguished in nomenclature, but they are both comparatively novel and have not yet achieved an unassailed position in the technical vocabulary. Even the manufacturers of apparatus are not quite clear as to the difference in terms. While the elevating and depositing methods are generally termed "spouting" in their catalogs, the troughs to convey the concrete are variously called "chutes" and "spouts." Furthermore, the average concrete worker uses the words interchangeably.

Which term would our correspondent apply to a system in which a concrete mixer on top of a slope dumps directly into a trough leading to a pier footing 150 ft. below? And would the same term apply to another part of the slope where the footing was only 10 ft. below the mixer but the method the same except for length of trough? The effect in the former case is the same as in the "spouting" system of the foregoing letter; in the latter we have the "chuting" system. At just what depth of cut or length of trough does the change take place?—Editor.]

Co-operation Conference

Sir—Your poignant editorial "Coöperate, but to What End?" in your issue of Apr. 27, should help stimulate engineers to develop a workable plan for federation of effort along lines of common interest. To continue your metaphor of the doctor examining the patient, you have touched a tender spot and the patient winces. It will help reach the correct diagnosis.

The Conference on Coöperation held in Chicago April 13 and 14 accomplished more than is written in the resolutions adopted. These merely took up the work where we left off and made provision for future progress. A careful observer might copy the resolutions triple space and freely interline them, wisely indifferent to criticisms that nothing was done. Some of the interlineations would be after this fashion:

Coöperation has been begun when representatives from St. Louis, St. Paul, Chicago, Philadelphia, Cleveland, Pittsburgh, and from state societies like Illinois, Iowa, North Dakota, Ohio, Kansas, and from other local, state and national societies, meet and exchange ideas, get acquainted and gather inspiration from hearing about each other's successes and failures. It is worthy of note that almost all the delegates were in constant attendance at the sessions and manifested an interest which will not be satisfied until the goal is reached.

An annual conference—congress, council or whatever other name is applied—would be well worth while if it served no other purpose than to furnish a forum for the exchange of ideas on subjects of common interest to all engineers. Let us pause to read Isham Randolph's expression in words of the spirit of the conference:

Let us have a central organization—call it what you will—which has no authority to command, but which has ears to hear and the voice to be heard, and let those ears be open to every plea or promise of common good, and let that voice go out to all affiliated bodies carrying this plea or this promise for the common good, and let us come together at least once a year and feel that "touch of nature which makes the whole world kin," and growing out of that kinship let us consider and do those helpful things which will bless our comrades and overflow with helpfulness to our country and our kind.

In the end all questions, and controversies arising from their discussion, are settled on fundamental principles. The fundamental principle that underlies the get-together movement among engineers is the same as has always led other bodies of men of common interests to band together. Why did the Chambers of Commerce in the various cities form a national body? Or why did the Thirteen Colonies form the United States? It might be well to reflect upon the reason of the near-failure of the Colonies in the Revolution. A re-reading of the history of that period is illuminating.

Someone has aptly characterized the movement toward coöperation among engineers as a ground swell. The desire to work together finds expression everywhere. The call, as you have pointed out, is for leadership which can bring the great mass of engineers into a vigorous, harmonious whole and use the forces thus organized for the benefit of the engineer and the community. Your editorial is an excellent incentive to thought. Thought will lead to action along the lines which, it is hoped, the subcommittee created at the conference will lay down.

C. E. Drayer,
Secretary, Committee on Engineering Coöperation.
Cleveland, Ohio, May 14, 1916.

The Montreal Centrifugal Pump

Sir—Your comments upon the basis of the performance of the centrifugal pump at Montreal are well taken. I think that every effort should be made in such matters to see that pumping engine guarantees are based upon the performance of the main engine unmixed, so to speak, with auxiliaries. The guarantee in this case should have been based upon the use of steam which entered the turbine, and none should have been extracted for auxiliary purposes during the trial. Only in this way are we able to have a measure of the state of the art of centrifugal pump and turbine design and means of comparison with pumping engines of other types.

That salesmen sometimes seek to take advantage of the lack of information of water-works officials in making guarantees of economy is well known. I have in mind such a case in a suburb of Boston, where the guaranteed duty was based upon the steam used less that condensed in the cylinder jackets, as if the jacket steam was not used by the engine as well as that which acted directly upon the pistons.

It has been my custom, and it should always be the custom, to base a performance upon the steam used by the engine itself as a measure of the merits of the engine and means of comparison with other engines. The exhaust steam from auxiliaries can be used for heating feed water, or after the acceptance trial is over it can be used in any way desired. Likewise after the trial, steam from a stage of the turbine can be extracted for saving fuel. At all events, whatever is done, let us have a means of judging of the performance of the pump and prime mover by themselves. F. W. Dean.

53 State St., Boston, Mass., May 26, 1916.

Quality of Bituminous Binder as Affecting Road Wear

Sir—No one with a knowledge of the subject would seriously disagree with the main contentions of Mr. Ripley's article in your issue of May 11 on "Lessons in Road Maintenance From New York State," or with your editorial in the same issue. There is, however, a phase of this subject that calls for supplementary comment. The inference one would naturally draw both from Mr. Ripley's article and from your editorial is that all New York State roads have performed in a substantially similar manner. This is not the case. On the contrary the records and even superficial observation will confirm the statement that a great many of the bituminous roads built in 1914-15 are not now in as good condition, despite the fact that they have cost more for maintenance, as are roads which were built in 1909-10-11.

The writer has before him a list of forty penetration-asphalt roads constructed from 1909 to 1911. Only twelve of these roads have cost anything for maintenance, although it is undoubtedly true that they should have received some attention. Some twenty roads could be mentioned in the same category; namely, that of roads which have carried heavy traffic for five or six years and are now in good condition, although it is undoubtedly true that a carpet coat would be a good investment from the point of view of prolonging the life of the road beyond what may be expected if the surface is not given a superficial application of asphalt and screenings.

The Spring Ave.-Troy road and the Indian Fields-Dormansville road are particularly good examples of the writer's contention that New York has many asphalt roads built five and six and seven years ago that have cost practically nothing for maintenance. Is it not significant that the roads that have given the best service are those that were built with certain materials under certain specifications and under certain supervision, while roads built with other materials at much later dates have, generally speaking, all gone to pieces? These older roads are carrying the identical traffic that has so greatly increased the maintenance on newer roads. Why is it that the

maintenance on the earlier roads is negligible while the maintenance on the newer roads has become so serious a factor?

In the opinion of those who have most carefully investigated the subject with a view to obtaining the truth of the matter for their own commercial enlightenment, New York's 1909-10-11 roads built with a natural asphalt binder by the penetration method have proved that they can economically carry the traffic imposed upon them.

Mr. Ripley mentions as one of the two main causes of deterioration "the reduction in the binding quality of the bituminous material." Of course it cannot be expected that a bituminous road the life of which depends upon the continued cementing power of the asphalt binder, will stand up if bitumens are used, the cementing power of which is quickly lost. New York is finding out that poor binders are a poor investment. The state has ample evidence, however, that good and lasting binders build good and lasting roads. It is not fair that the failures due to poor materials and poor workmanship should be used to cast discredit upon good materials and good workmanship.

DANIEL T. PIERCE,
Barber Asphalt Paving Co.

Land Title Building, Philadelphia, May 23, 1916.

Paving Problems in Texas and Missouri Cities

Sir—In some of your recent issues I have noticed articles about street paving in Texas. In your issue of Apr. 27 you pointed out that the Texas homestead law causes paving contractors to add a charge of about 10c. per sq.yd. to their bidders for pavement. Let us step over in Missouri and see the conditions there.

In Kansas City, special tax bills are issued against the adjoining property and sometimes against what is called the benefit district—frequently over the protest of private property owners, who must pay these bills whether they want the street improved or not. The contractor goes over the streets to be paved and if there is any bad looking property adjoining them, which is very often the case, he adds about 12 or 15% to his bidding price and then, as these bills have a long time to run, and he is not given them until the work is completed, he must find a way to obtain money to carry on the work. He goes to some investment company, which takes his bills at a discount of say 10%, which makes it necessary to add this also to his bid to balance the good ones from the bad ones. He does the work, the investment company allows him the money, and then the company holds these bills for collection, which are drawing 7% interest. If a special tax bill for paving for $100 was levied against a piece of property and the first year the owner paid $50, the second year he would have to pay 7% on the $100, and continue to do so until the entire principal is paid. As the city does not pay for any part of street improvements whatever, I think the cost of paving streets in Texas is about 10% cheaper than the cost of pavement in Missouri.

Bartlett, Tex., a town of about 4,000 people, recently let a contract for paving its streets—27,200 sq.yd. at $2.05 per sq.yd. This is to be 3-in. vertical fiber brick laid on a 1½-in. sand cushion with a 5-in. concrete base and with cement filler. I have seen 6-in. concrete pavement let in Kansas City, Mo., for $1.48 per sq.yd., which is indeed high for 6-in. concrete pavement. If Kansas City would pay the contractor cash and give him monthly estimates, I am sure that the cost of pavement would be reduced about 15% at least.

Do not let us be too hard with Texas, as she is just now waking up to the fact that she needs good streets and roads, as is shown by the example the little town Bartlett has set.

GEORGE CHARTRAND.

State Bank Building, Kansas City, Mo., May 12, 1916.

More on Flood Diversion Ditch Washout at Sioux Falls

Sir—In your issue of May 18, p. 965, there is an item about a washout on a concrete-lined ditch, at Sioux Falls, S. D. I send you herewith a photograph wherein you can see that a hole has been washed out about 350 ft. long and about the same width, and where the water comes down is a fall of about 40 ft.

From the highway bridge over the ditch, in the rear of the view, to the river in the foreground is about 1,000

DITCH WASHOUT DIGS DEEP HOLE NEAR SIOUX FALLS

ft. and the drop is 101 ft. About one-half of the water falling comes out from underneath the concrete trough of the ditch. I do not know who is to blame for the design, but if proper precaution had been taken to keep the water from getting under the concrete, the washout would not have occurred.

ADOLPH YAPPEN.

Grand and N. California Ave., Chicago Ill.,
May 22, 1916.

Publication of Los Angeles Aqueduct Report

Sir—The Los Angeles Board of Public Service Commissioners has nearly ready for the press the "Final Report of the Construction of the Los Angeles Aqueduct," which has been in preparation over a year. Practically all the phases of the great work are taken up and painstakingly set forth in all necessary detail. Following a history of the enterprise, and an engineering description of the project as a whole, the report includes chapters on hauling, municipal tufa cement manufacture, building dams by the sluicing method, excavation, construction of concrete conduits, tunnel boring, the theory and practice of the bonus system as applied to municipal work, the fabrication of the steel siphons 7 to 11 ft. in diameter and concrete

pipe of 10 ft. in diameter, cost keeping and accounting, sanitary aspects of the water supply, etc.

Throughout the volume are tables of costs of the various classes of work, as well as running comments on mistakes made, difficulties overcome or shortcuts taken.

The volume will be 8½x11 in. in size, of about 350 pages, in stout library binding and illustrated by 62 full-page and 24 half-page halftones and 34 line cuts of engineering designs.

The Board of Public Service Commissioners realizes that this report on a great engineering work will be desired by engineers and engineering reference libraries in all parts of the United States and abroad and desires to make it available to them. The cost of publication, however, forbids free distribution and the Board has therefore decided to fix a moderate price on the volume, less than the actual cost of printing and postage. This price is $1.95, delivered.

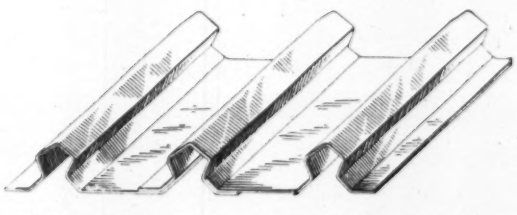
The Board is not in the publishing business, derives no profit from the sale of the volume and has no interest in its distribution other than the desire to make the record of the great work done for the City of Los Angeles available to engineers who desire it. Only the number of copies will be ordered printed for which orders have been received at the time of going to press, plus the number the Board may require. Orders must therefore be made immediately to insure acceptance. Checks should be made payable to the Los Angeles Department of Public Service, 645 South Olive St.

R. F. DEL VALLE,
President, Department of Public Service.

Los Angeles, Calif., May 22, 1916.

Integral Steel Plate To Make Concrete Tank Water-Tight

Sir—In recent years there have been numerous discussions and descriptions of circular reinforced-concrete storage tanks that seem to leak more or less. The writer does not believe that this condition is serious from the standpoint of a complete collapse; but if these leaks are allowed to continue from year to year, it will be found that the tank will soon be beyond repairs, and it would prove to be serious, especially if a town or city is dependent upon the water-supply from such a tank or standpipe. The vital point in question is how to make such a tank water-tight, for in the writer's opinion it can be safely said that under the accepted methods of design and construction a reinforced-concrete tank of a size larger than can be built in one operation cannot be made water-tight without an elastic membrane forming a water-tight seal throughout. This membrane should be protected by a concrete, brick or plaster lining, as it otherwise will be injured by ice that may freeze on the inside.



TYPE OF STEEL PLATE SUGGESTED AS FORM AND REINFORCEMENT IN REINFORCED-CONCRETE TANKS

Accordingly, the writer has decided that in future constructions of this type he will adopt an innovation in design. The patented steel plates shown in the accompanying view are used in construction for many purposes, such as forms, walls, roofs, partitions, floors, etc. By using them as forms and vertical reinforcement it will be seen that the interior of a tank would have one continuous sheet of metal, as the plates are solid and not perforated. The circumferential steel reinforcement (which should be round rods) is placed in the forms, fastened and hung from the outside plate of the tank by means of wire brackets, which would eliminate the expensive operation of wiring the steel together and holding it in place. Care should be taken to leave all field joints in the concrete in the middle of the plates—the point of greatest strength.

After the plates, steel and concrete are placed and the bracing removed, the interior and exterior surfaces of the plates could be coated with 1 in. or more of gunite (cement mortar applied with the cement gun). The exterior could be left with any desired finish. If the top of the tank is to be covered, the plates can be used for forms as well as reinforcement in connection with the steel-frame or concrete-beam construction which goes to make up the roof.

The writer feels justified in stating that anyone would be safe in guaranteeing such a structure to be water-tight and permanent.

N. F. AMBURSEN.

12 West St., Boston, Mass., Apr. 22, 1916.

NOTES AND QUERIES

Bridge Reconstruction on the Fort Dodge, Des Moines & Southern Ry. was described in "Engineering News," May 25, 1916, and the contractor was the Ferro Construction Co., of Chicago, not Farrell Construction Co., as stated.

Pirahy Tunnel, Brazil—By a typographical error in the article "Rapid Tunneling in Brazil," by J. C. Balcomb, "Engineering News," May 18, p. 925, the maximum miss in levels was stated in one place to be 0.181 ft. instead of the correct figure 0.081 ft. The latter was given correctly in the accompanying table. Use of a comma instead of a period to mark the decimals in this table made the tunnel 27,657,174 ft. long instead of 27,657.174.

Road Maintenance in New York—Attention has been called to an important stenographic error in the article "Lessons in Road Maintenance from New York State," by T. M. Ripley, in "Engineering News," May 11. By the substitution of the word "maintenance" for "bituminous" in the fifth line, third paragraph, p. 887, the meaning has been distorted. This paragraph should read:

> The construction of a bituminous top required entirely different treatment than did the waterbound top, and engineers and contractors were both ignorant as to the methods required. It took several years to learn the most essential points in the construction of a bituminous top, in order that the road might be smooth when completed—and even today this desirable condition is not always obtained.

An Argument for Licensing Engineers—D. E. C. reports the recent remarks of a young engineer on the subject of licensing engineers, substantially as follows: The young engineer remarked that just as he was well started in college he had to quit. Since then he has studied until he feels that he now knows as much as a graduate engineer. Yet he is ever up against the prejudice in favor of the graduate. He wants a license which will show that as a result of public examination he has the same general kind of knowledge as he would have acquired had he continued in college and as would have been attested more or less directly by his diploma. Such a certificate, he thinks, would establish his status as an engineer. Our correspondent remarks, after paraphrasing the young engineer's conversation as given above: "To me it is noticeable that the young men are in favor of regulation. The future will reflect this."

Dominion Reports 418,500 Hp. on Winnipeg River

The report of the Dominion Water-Power Branch, Ottawa, Canada, just printed (as Water Resources Paper No. 3), shows a possible development of 418,500 hp. continuous 24-hr. power on the Winnipeg River between Lake-of-the-Woods and Lake Winnipeg in Manitoba. This stream is at the borders of the fuelless prairies of the province, the center of gravity of power being only 62 mi. from the City of Winnipeg.

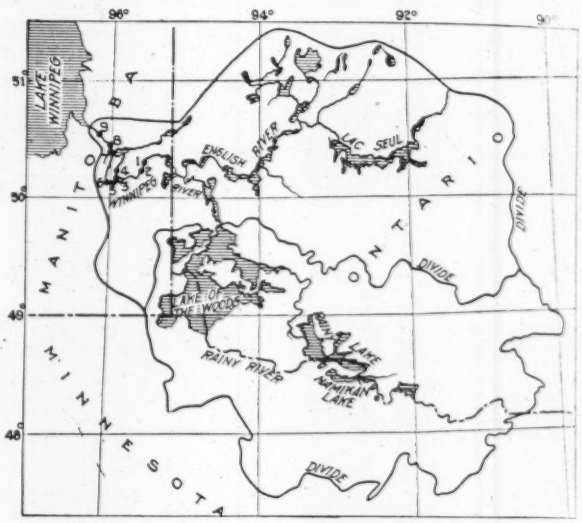
So many applications were filed for development of the several rights that a reserve was placed on all the undeveloped sites until the whole river could be studied by the Dominion. For this survey, the advice of J. R. Freeman, of Providence, R. I., and J. B. McRae, of Ottawa, was secured, and a preliminary reconnaissance was made in 1911 by them in company with J. T. Johnston, now Chief Hydraulic Engineer of the Water-Power Branch (author of the report). On their advice, a complete contour survey of the river was made, with cross-sections and soundings at all falls and rapids. Seven sites have been selected, at which practically all the undeveloped fall of the river can be utilized, and detailed designs have been prepared for determining the engineering and commercial features and costs. The unregulated minimum flow has been found to be 12,000 sec.-ft. for those plants, but the storage afforded by the Lake-of-the-Woods and auxiliary reservoirs may raise this to 20,000 sec.-ft.

Existing Developments

The Winnipeg River in Manitoba does not adapt itself to small developments. The first large plant built was that of the Winnipeg Electric Railway Co. on the Pinawa Channel, built in 1902 to 1906. There are three diversion weirs across the main and secondary channels, each of them governed by a control dam. The head is 39 ft. and there are four 1,000-kw. and five 2,000-kw. generating units; 8,000 sec.-ft. is the necessary flow down this channel.

In 1911 the City of Winnipeg's municipal station at Point du Bois was put in operation. A concrete gravity-section dam was thrown across a narrow part of the main channel and a forebay channel cut across an adjacent point. The head is 45 ft. and the present installation comprises five 3,000-kw. and three 5,000-kv.-a. units. There is space for eight more units and a flow of 24,000 sec.-ft. will ultimately be required.

There are a few plants on the Winnipeg River in Ontario to be noted in any discussion of the Winnipeg River, although the Dominion Water-Power Branch has no jurisdiction in the Eastern provinces. In 1893 the town of Kenora built a municipal station on the eastern outlet of Lake-of-the-Woods where there was an abrupt drop of 20 ft. from lake to river. This now has four 625-kw. generators in a power house which is combined with a dam. In Keewatin, near Kenora, the Lake-of-the-Woods Milling Co. uses some 4,000 hp. There is a



DRAINAGE AREA OF WINNIPEG RIVER

1—Winnipeg Municipal Plant; 2—Slave Falls Site; 3—Upper Pinawa Site; 4—Winnipeg Electric Railway Plant; 5—Upper Seven Sisters Site; 6—Lower Seven Sisters Site; 7—McArthur Falls Site; 8—Du Bonnet Site; 9—Pine Falls Site.

15,000-hp. development of the Minnesota & Ontario Power Co. on the Canadian side of the Rainy River at Fort Francis.

About 15 mi. below Kenora are White Dog Rapids where a 45-ft. drop makes possible the development of 75,000 hp. On the English River coming down on the north from the Lac Seul region are several sites where from 20,000 to 40,000 hp. each could be developed.

In the district studied, the Laurentian granite lies practically on the surface and the river consists of a series of broad basins with abrupt changes in level occasioned by granite outcrops forming distinct ridges of elevation higher than the pond bed above. As a result the gradient between falls is negligible and concentration is possible at a few sites, making use of practically the

CONCENTRATION OF POWER ON WINNIPEG RIVER IN MANITOBA

Natural Conditions		Proposed Developments										
					24-Hr. Power		Turbine Installation		Local Pond-age,	Local Flooding,	Estimated Costs	
Falls	Head, Ft.	Falls	Head, Ft.	Miles from Winnipeg	12,000 Sec.-Ft.	20,000 Sec.-Ft.	12,000 Sec.-Ft.	20,000 Sec.-Ft.	Acres	Acres	Construction	Per kw.-hr., 100% L. F., Cent.
Pine	9											
Masqua	5	Pine	37	64	37,900	63,100	6–10,000	10–10,000	3,642	375	$4,407,000	$0.108
Silver	21											
Whitemud	12											
Little du Bonnet	8	Du Bonnet	56	64	57,300	45,500	12–10,000	14–10,000	1,700	360	6,551,000	0.102
Grand du Bonnet	35											
Second McArthur	6	McArthur	18	62	18,400	30,700	11– 2,500	17– 2,500	38 sq.mi.	...	2,746,000	0.136
First McArthur	6											
Lower Seven Sisters	16											
Fourth Seven Sisters	8	Lower Seven Sisters	37	52	12,600	37,900	.....	6–10,000	9,545	70	3,409,000	0.132
Third Seven Sisters	8											
Second Seven Sisters	9											
First Seven Sisters	10	Upper Seven Sisters	29	55	9,900	29,600	.....	8– 6,000	8,470	...	2,724,000	0.138
Diversion Weir	11											
Slave	19	Slave	26	74	26,600	44,400	8– 5,000	13– 5,000	1,300	100	2,327,000	0.117
Eight Foot	7											
Point du Bois	31	Winnipeg			21,100	51,800	.....	.....	...	...	.....	.....
Lamprey	16	Municipal	45	76	additional	additional						
Upper Pinawa Channel	..	Upper Pinawa	18	58	...	12,300	.....	4– 4,500	9,250	425	1,280,000	0.159
Developed to date	..		..	..	53,200	53,200	.....	.....	....	...	.....	.....

nature fall. The accompanying table shows the present conditions and proposed modifications.

The whole basin, shown in the accompanying map, is dotted with lakes of greater or smaller size, the most important ones for the control of the Winnipeg River being Lake-of-the-Woods, Namikan and Rainy, and for English River, Lac Seul, Minnitaki and Sturgeon; 111 of the lakes have been large enough to investigate as natural storage basins. A minimum flow of 12,000 sec.-ft. in Winnipeg River has been established and regulation to 20,000 sec.-ft. is assured. The drainage area above Lake-of-the-Woods, the key to this regulation of the river, is 26,100 sq.in. This and Rainy Lake will have to store 181 billion cubic feet, giving a draw-down in level of 5 ft., the low level being reached, however, only in extremely dry years. Lac Seul can be relied on for 6,000 sec.-ft. and 10,000 by full practical control; 4,000 sec.-ft. will be necessary to make up the desired 20,000 in Winnipeg River.

The Water-Power Branch urges that the Government must build and operate the storage-control works. Central control should be exercised by joint action of the Branch and the Hydro-Electric Power Commission of Ontario. There would be an engineer in sole and direct charge of the regulation of the whole runoff.

Water-Power Administration in Prairie Provinces

The water powers of the Canadian provinces of Manitoba, Saskatchewan, Alberta, the Northwest Territories and the Yukon are under control of the Dominion Government and are administered by the Water-Power Branch of the Department of the Interior. The announced policy of the branch is to "encourage desirable development of water resources, but to discourage uneconomic and wasteful projects, to insure providing at each site for future development of maximum available power, to insure that units on a river system have a place in a comprehensive plan, to secure adequate storage works in the benefit of all affected developments, to prevent unnecessary duplicate expenditures on the part of competing interests, to protect the consuming and investing public against ill-advised schemes and unsafe structures and to prevent evils of monopolistic control of water resources through Government supervision and by periodical revision of rates," etc.

Complete regulations govern the grant of water powers to private parties; detailed data and designs have to be submitted with each application, and mere priority of application does not carry any rights. In making a grant the Minister of the Interior fixes the time within which works must be begun, the minimum annual expenditure and the amount of water power to be developed within 5 years. The right to use water extends for 21 years, and the lease of Dominion lands necessary in the development of power runs for the same term. In the absence of public lands the minister fixes the limits where the applicant may exercise rights of appropriation. The licenses are renewable for three consecutive terms of 21 years each, and in case a plant is taken by the Dominion the owner is paid for the value of tangible works and land held in fee. No value is allowed for the rights granted or for any profits arising therefrom. The value of land and works is to be fixed by three arbitrators in case of seizure.

Where a licensee does not develop the full capacity of a site and the Government finds more power required by the public demand, it may offer a supplementary license for the added rights to the licensee. If he does not accept it and complete the works, or if the present works would be a hindrance in developing a larger amount of power, or if the granted irrigation rights have prevented advantageous operation, then to the value of the seized works is added a bonus—30% for works in operation less than 5 years, 25% for 5 to 10 years, 20% for works in operation 10 to 15 years, 15% for 15 to 20 years and 10% for over 20 years' operation.

Where the possibilities of a given stream have been thoroughly investigated by the Water-Power Branch and a scheme of development is dictated for the whole river, all water-right grants are for works to be built in general accordance with the announced systems.

Silicon Steel for Bridges

A special feature of the new Ohio River bridge at Metropolis, Ill. (for the Chicago, Burlington & Quincy R.R. and Nashville, Chattanooga & St. Louis R.R.) is the extensive use of silicon steel in the trusses. In steel with 0.30 to 0.35% carbon, the silicon averages from 0.30 to 0.40%. This metal is used for the top chords, main posts, main diagonals, and end panels of the bottom chords. All other rolled structural material is of medium steel. The eyebars and pins are of nickel steel. The accompanying table gives the main characteristics of the steel, as shown by tests on actual specimens.

The effect of the silicon in the steel is to give a higher yield point and ultimate strength, without sacrificing the reduction of area or the elongation in specimen tests. In other words, an increase in strength is obtained without the metal becoming hard and brittle.

The same grades of steel are to be used in the new bridge of the Chicago, Burlington & Quincy R.R. at Kansas City, Mo. C. H. Cartlidge, Bridge Engineer of this railway, is engineer for both the bridges mentioned. The steel is being supplied by the American Bridge Co.

TESTS OF SILICON STEEL AND OTHER STEEL FOR THE OHIO RIVER BRIDGE AT METROPOLIS, ILL.

Grade of Steel	Piece	Size, In.	Length, In.	Elastic Limit, Lb. per Sq.In.	Ultimate Strength, Lb. per Sq.In.	Elongation in 8 in., Per Cent.	Reduction of Area, Per Cent.	Fracture	Carbon, Per Cent.	Manganese, Per Cent.	Phosphorus, Per Cent.	Sulphur, Per Cent.	Silicon, Per Cent.	Nickel, Per Cent.
Silicon steel....	Plate	42x1¾	435½	53,870	86,000	18.5	30.8	½ cup	0.34	0.74	0.016	0.036	0.320	
Silicon steel....	Plate	42x1¾	435½	50,160	81,350	19.7	37.1	½ cup	0.31	0.68	0.016	0.031	0.350	
Silicon steel....	Plate	42x1¾	608	47,450	86,780	18.5	40.2	½ cup	0.29	0.70	0.020	0.037	0.400	
Silicon steel....	Plate	42x1¾	703	49,660	83,640	19.7	43.7	Angular	0.30	0.65	0.016	0.034	0.350	
Silicon steel....	Angle	8x8x1½	608	51,400	89,280	19.7	41.9	Silky, ½ cup	0.32	0.52	0.023	0.030	0.300	
Silicon steel....	Angle	8x8x1½	595	48,000	82,640	16.6	31.7	.....	0.35	0.57	0.024	0.040	0.274	
Silicon steel....	Angle	8x8x1½	690	50,720	84,220	19.2	46.3	Silky, Ang.	0.35	0.52	0.029	0.040	0.300	
Medium steel...	Plate	33x ¾	348	38,620	63,400	27.5	57.4	Cup	0.22	0.35	0.014	0.028	.....	
Medium steel...	Plate	21x1½	110	38,000	62,390	26.7	52.0	½ cup	0.25	0.54	0.014	0.047	.....	
Medium steel...	Angle	8x8x ¾	390	38,100	60,600	28.5	54.0	Cup	0.20	0.59	0.020	0.026	.....	
Nickel steel*...	Eyebar	12x1⅜	436	57,000	92,640	13.1 (in 18 ft.)	40.2	100%, silky cup	0.34	0.60	0.016	0.026	0.060	3.27

* Note. Full size test of nickel-steel eyebar; elongation in 18 ft.

Plattsburg Dam Goes Out

SYNOPSIS—Six bays of hollow reinforced-concrete dam on glacial drift fail, after continued leakage through foundation. City authorities had made no effort to control leakage since early trench cutoff had been temporarily effective.

The hollow reinforced-concrete dam of the City of Plattsburg, N. Y., at West Brook Reservoir No. 3 failed at about 9 a.m. on May 15. This apparently was due to the destruction of foundations under Bays 3 to 7 after several weeks' leakage. Six of the 22 bays, or 90 ft. of length, were torn out and pieces washed a mile downstream.

As shown in Fig. 1, and as described in detail in *Engineering News*, Jan. 20, 1916, this was a 22-bay structure completed early in 1915 and creating a water-supply reservoir in glacial drift. There had been some trouble in making the reservoir tight from the first (although the reservoir was filled in the spring of 1915) and a trench 6 ft. to 22 ft. deep, 3 ft. wide at the bottom and 5 ft. across the top in front of the upstream toe had been filled with puddled clay. No leaks then showed under 14 ft. of water—all the test then possible. When the reservoir was filled, early in March of this year, there was little or no leakage, but as frost came out of the ground a little weepage was noted in Bay 8, a slight flow from the holes in Bay 4 and some traces in the bays to the east. The weep holes in Bay 8 are reported to have been plugged by some city official a few weeks before the break.

It is reported that there was no person in charge of this dam and that no systematic watch or measurement of the leakage had been kept since Jan. 1, 1916, when the city administration that built the dam went out of office. The new mayor and public-works board decided that a city engineer was expensive and unnecessary, such engineering work as was done being paid for on a per diem basis. If anyone assumed responsibility for the structure, the fact is not now known.

On account of this condition of affairs no one knows just what happened at the time of failure. An examination of the site shows that the serious underflow may have developed first under Bays 3 or 4 and then by scour under 5 and 6 as the level dropped. Apparently there was flow first from a point in front of, and 40 ft. or more above, Bay 3. Fig. 3 shows a crater-like depression extending from in front of No. 1 buttress along the 900 ft. level for about 75 ft. upstream and coming back to the dam in front of Buttress 5. This area covers what was the west slope upstream. About 10 ft. below the top an 18-in. sand seam is to be seen, and above this are the typical fine-silt strata described in *Engineering News*, Jan. 20, 1916. Considerable material has fallen from the west bank, which seems to have been left more or less vertical at first.

There is a second hole extending in a semicircle, 25 ft. in diameter, from the toe of Buttress 5 to Buttress 8. This is 10 to 15 ft. deep and extends downstream to the heel of the dam. The cutoff wall is still in the west bank at the top, and the clay fill placed in 1915 largely remains in place along the toe from Buttresses 8 to 18. Just below the dam in the brook bed is a deposit of gravel and sand 8 ft. deep, 30 ft. wide and 200 ft. long.

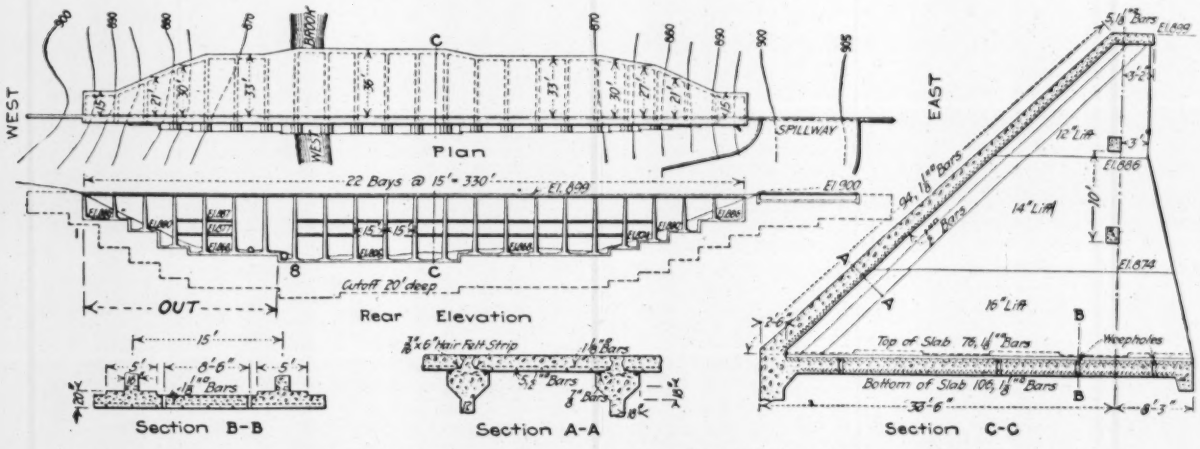


FIG. 1. REINFORCED-CONCRETE DAM AT RESERVOIR NO. 3, PLATTSBURG, N. Y.
Reprinted from "Engineering News," Jan. 20, 1916

The deck appears to have given way while there was still considerable water in the reservoir (the storage capacity was 72 million gallons) for the water rose some 10 ft. above the brook bed and cut a path 50 to 80 ft. wide along the thickly wooded banks for the 2 mi. down to Reservoir No. 2. The brook bed now looks like a small river in dry season. Two small timber bridges a mile below the dam were carried away.

A large amount of silt and vegetation was carried into Reservoir No. 2. The caretaker here by hard work got the flashboards off the spillways of this and No. 1 dam. Both these structures are of earth with concrete core walls; there was little damage beyond some wash on the downstream slope of No. 2. The flood swept safely over No. 1 and into the Saranac River without further damage.

Primary responsibility appears to rest on the existing city officials for what is reported to be an absolute neglect of a dam known to be leaking, and for plugging the lowest-level weepholes. But some measure of responsibility may rest on the previous administration for proceeding in such a delicate task as building a reservoir in glacial drift without the best of engineering advice from start to finish. They retained a consulting engineer for a short period but did not accept advice as to the disadvantages of the site they had selected, nor as to the necessity of employing a contractor and inspector especially experienced in dam building.

The illustrations, showing the collapse of the failed section, are similar to the views of the Stony River dam, West Virginia, which failed in January 1911 (see *Engineering News*, Jan. 22, 1911, p. 212)

FIGS. 2 TO 7. VIEWS OF THE PLATTSBURG DAM AFTER FAILURE

2—Upstream side of break from west bank, showing 15-ft. hole along standing portion and 6-ft. bank of material carried from west bank under floor; 3—Upstream side of break from east, showing crater in west bank; 4—Stream bed at break, from upstream; 5—From 500 ft. below dam, showing path made by water; condition existing for one mile below, previously thickly wooded; 6—Looking east, cutoff wall in bank at right; 7—Close view of Bay 7, showing deck slab still up and waste pipe intact.

News of the Engineering World

Chicago Drainage-Canal Supply May be Limited by Law

An amendment to the River and Harbor Appropriation Bill adopted by the Senate just before its final passage of that act limits to 250,000 cu.ft. per min. the amount of water that may be drawn from Lake Michigan by the Chicago drainage canals. The amendment was offered by Senator La Follette of Wisconsin, representing the lake interests that have long protested against the heavy draft of water through the drainage canals because of its effect upon the levels of the Great Lakes. In presenting the amendment Senator La Follette read a report by Gen. W. M. Black, Chief of Engineers, dated May 13, 1916, in which the controversy over the flow through the Chicago drainage canal was reviewed.

As engineers who are familiar with the history of the Chicago drainage canal are aware, that work was built without any authority from Congress or any other department of the Federal Government to divert water from the lakes, and Congress has never given official sanction to it. On the completion of the canal in 1899 a conditional permit was granted by the Secretary of War limiting the flow in the canal to 5,000 cu.ft. per sec. On complaint of the navigation interests this order was modified on Dec. 5, 1901, limiting the diversion to 4,167 cu.ft. per sec., or 250,000 cu.ft. per min., and this is now the legal limit. Repeated applications from the sanitary-district authorities to increase the amount of this flow have been refused. In 1907 application to draw an additional 4,000 cu.ft. per sec. through the Calumet River was denied by the department. Evidence of intention to make such diversion, notwithstanding the department's refusal, led to suits for injunction by the Attorney General of the United States, filed in March, 1908, and in October, 1913. These cases are awaiting decision in the United States District Court for the northern district of Illinois.

Notwithstanding the legal limitation, the average daily flow through the Chicago River into the drainage canal has been in excess of 7,000 cu.ft. per sec. since 1910, and measurements by the United States Lake Survey indicate a flow in excess of 8,000 cu.ft. per sec. By way of comparison, General Black stated that this flow is about equal to the low-water flow of the Mississippi River at St. Paul and about half as great as the low-water flow of the Mississippi at Keokuk. General Black stated that the continuous withdrawal of this volume of water will result in the permanent lowering of the surface of Lakes Michigan and Huron by 5 in. or more and of Lake Erie by nearly the same amount. The still greater diversion of 10,000 cu.ft. per sec. or more contemplated by the Illinois authorities will lower Lakes Michigan and Huron by 6.9 in.; Lake Erie by 5.4 in.; and Lake Ontario, 4.5 in. These figures relate to mean lake level. A much greater lowering will occur at low water.

Senator La Follette also presented a letter from the Secretary of the Milwaukee Merchants and Manufacturers Association dated May 26, 1916, stating that the lake-level records kept by the Government engineers show that the levels of the lakes have already been reduced from 6 to 10 in., involving a loss of millions of dollars to the navigation interests. The letter summarized the position of the lake shipping interests as follows:

> The disposal of sewage at Chicago can well be effected with the original grant of water—namely, 250,000 cu.ft. per min. The excess illegally taken—350,000 cu.ft. per min.—is used to create water power at Lockport, Ill. The Illinois ship-canal project, under which the state proposes to expend $5,000,000 on the improvement of the Illinois River and connecting channels to Chicago, is fostered more largely for the purpose of insuring the continued illegal diversion of water, or rather to secure a legal sanction of the same, than to provide a commercial utility. In other words, the real purpose behind the cry of sanitation and ship canals is the continued steal of a colossal flow of lake waters for power purposes. We therefore enter a most earnest protest against any action by the Secretary of War or on the part of Congress that will sanction or legalize the present unwarranted diversion of lake waters into the Chicago drainage canal.

The bill must go to conference, be agreed upon by both houses and signed by the President before becoming law.

Steel and Wood Water Mains at Butte, Mont.

The water mains at Butte, Mont., are under specially trying conditions, owing to the facts that the ground beneath the city is honeycombed with mine drifts and tunnels and that frequent disturbance and settlement occur. For these reasons the Butte Water Co. uses steel pipe, as settlement of the surface does not cause the pipe to break, and leaky joints give notice before the leak becomes serious. The officials consider that with cast-iron pipe such settlement might cause serious breaks and result in great damage.

The use of the steel pipe has been attended with great success, and some of it has been in the ground in service since 1886. The original cost, cost of laying and cost of repairs are said to be much less than for cast-iron pipe. The life of the steel pipe is less than that of cast-iron pipe. The damage from electrolytic action also is believed to be much greater than with the latter, although this is simply a theory based upon the fact that the pipe is much thinner and the electrolytic action would naturally be faster.

The steel pipe is made by the National Tube Co. and has National coating and the Matheson joint, which has proved very successful and has replaced the Converse joint formerly used. It is found to take less lead, to require less skill in setting it up, and to keep tight if ordinary care is taken. During the past three years there has been laid about 5 mi. of 20- and 24-in. steel pipe with these joints, and there was only one leaky joint on the extension. While this record is a good one, it is due partly to the system of having every joint carefully inspected by an expert calker before it is covered.

For the influent pipe lines, continuous-stave pipe with steel bands has given great satisfaction. In 1892 about 9 mi. of 24-in. redwood pipe was built, and a careful

inspection of this line in 1914 showed it to be in excellent condition. The cost of maintenance has been negligible. Since 1892 over 40 mi. of continuous-stave pipe of 24- and 26-in. diameter has been laid and has proved entirely successful.

From the experience with wood pipe a rule has been adopted of never putting the pipe under a static head of less than 50 ft., as the only disintegration discovered in these pipe lines is where the pipe is set very close to the hydraulic grade and the pressure is not sufficient to keep the wood thoroughly saturated.

The foregoing information has been furnished by Eugene Carroll, Vice-President and Manager of the Butte Water Co.

Federal Government Will Build a Nitrate Plant

The Army Reorganization Bill as finally enacted authorizes the President to make an investigation to determine the best process "for the production of nitrates and other products for munitions of war and useful in the manufacture of fertilizers and other useful products." He is further authorized to select a water-power site or other site and to construct a plant for the manufacture of such product. The products of the plant are to be used for military and naval purposes to such extent as the President may deem necessary, and any surplus may be sold under such regulations as he may prescribe. The bill does not specify the capacity of the plant, but $20,000,000 is appropriated for its construction and an issue of Panama Canal bonds to raise the money is authorized in case sufficient funds in the treasury are not available. A provision is inserted that the plant must be operated "solely by the government and not in conjunction with any other industry or enterprise carried on by private capital."

In view of the widely published fact that one of the most needed measures for national defense is the provision of a supply of nitrates which will be available for use at any time the shipment of nitrates from Chili is interrupted, there is no doubt that the government will proceed promptly with the construction of the plant.

Starting Philadelphia's Huge Sewage-Works Project

The initial part of the great sewage-disposal project which the City of Philadelphia has in hand is made possible by the $3,200,000 of bonds just authorized by popular vote, together with a fund of $500,000 already available. The disposition of the two sums is thus outlined in a letter to *Engineering News* from Chester E. Albright, Chief Engineer and Surveyor, Bureau of Surveys, Department of Public Works of Philadelphia:

With the $3,700,000 it is expected that land will be purchased for the sites of the southwest and northeast sewage-treatment works, that the Frankford Creek high-level intercepting sewer will be constructed, that the Frankford low-level intercepting sewers will be constructed with a connection to the upper Delaware intercepting sewer, that a pumping station for the low-level sewage will be built at the Northeast works, and that works for the treatment of the sewage collected by the Frankford Creek intercepting sewers will be constructed at the northeast site.

This is in practical conformity to the report of the Bureau issued in 1915.

Already a little less than a mile of 8½-ft. sewer is under contract, and it is expected that the rest of the Frankford Creek high-level intercepting sewer will be placed under contract very shortly. Surveys are being made and contract drawings will be prepared for the low-level sewers as rapidly as possible, and we look forward to the restoration of Frankford Creek to a clean condition within the next few years.

An abstract of the recommendations made in a report on sewage disposal for Philadelphia by George S. Webster, then Chief of the Bureau of Surveys, George E. Datesman and W. L. Stevenson appeared in *Engineering News* May 27, 1915, page 1051.

A Commission on Waterways and Public Lands will be appointed by Governor McCall, of Massachusetts to succeed the Directors of the Port of Boston and also the Massachusetts Harbor and Land Commission, both of which have been abolished by recent legislative action.

Chicago Voted $3,750,000 on June 5 for extending its municipal street-lighting system. There will be a generating station at the municipal garbage incinerator and three distributed substations. The new equipment is to include 5,800 arc lamps and 25,400 incandescent units.

Illumination of the Statue of Liberty in New York Harbor is provided for by a Senate amendment to the River and Harbor Bill. By this amendment the government is authorized to accept a fund of $30,000, to be raised by popular subscription by the "New York World," for the construction of a plant for illuminating the statue. The government is to maintain and operate the plant after its completion.

The Elimination of Noise from New York City transit lines is to be investigated by a committee made up of Public Service Commissioners Wm. Hayward and Travis H. Whitney and Clifton W. Wilder, electrical engineer of the commission. The committee is to investigate the causes of noise in surface, elevated, and subway cars and trains, and recommend any changes in structure, equipment, and methods of operation which may tend to decrease noise.

Bonds for a New Water-Supply for Oklahoma City, Okla., to the amount of $1,500,000 were authorized on May 20 by a vote of 3,452 to 1,596. The proceeds will be used to develop surface supply by storage on the North Canadian River. At the same election $200,000 were voted for sewerage improvements. Three or four months of preliminary work will be necessary before the water-supply project can be put under construction. Guy V. McClure is City Engineer of Oklahoma City.

The Refuse Destructor at Atlanta, Ga., over the acceptance of which there has been a protracted controversy, apparently due largely if not wholly to a change in administration just after the contracts were signed, was taken over and put in operation by the city on May 14, in accordance with the court decree issued the previous day. The court awarded The Destructor Co., New York City, its claims in full, and directed that the costs of the suit should be divided equally between the city and the company. The destructor is of the Heenan type.

A State Highway Commission for Georgia is provided for in a bill to be introduced in the legislature when it meets this month. The bill provides for three "commissioners-at-large," one of whom shall be the Dean of the Engineering of the University of Georgia, and also for a State Highway Engineer at a salary of $6,000 a year. The commission would collect the motor tax, and the Penitentiary Board would turn over to it 15% of the convicts of the State. Opposition to the latter provision is being made by the Georgia Society of Wardens, Superintendents and County Commissioners, which has prepared a bill designed to leave the control of convicts in the hands of the counties.

The Alaska Coal Fields were opened on June 2 to lease by mine operators. It is ten years since the Alaska coal fields were withdrawn from private entry and development. Secretary Lane has now restored about 33,370 acres of coal lands in the Bering River district and about 13,920 acres in the Matanuska district. These coal lands will be leased in tracts varying from 200 to 1,300 acres in size; the leasing units offered number 79. The leases are to be for a period of 50 years with a royalty to the government of 2c. per ton for the first five years, 5c. for the next 20 years, and a royalty not in excess of 5% of the selling price of the coal for the remaining 25 years. Proposals for leases are invited by the government, which will give preference to those who will make the largest investments and the earliest commercial developments.

Water Must Be Supplied by New York City to municipalities in Westchester County, according to the terms of the legislative act recently signed by Governor Whitman. Under previous legislation the consent of the State Conservation

Commission was necessary before this could be done. The City of New York, the Merchants Association and other organizations strongly urged the Governor to veto the bill, but he stated that New York City had the matter wholly within its own control since it was able to fix the water rate to be charged—apparently meaning that the rates to be charged municipalities in Westchester County are to be the same as those charged by and in New York City. The Governor added in his memorandum:

If it [New York City] is financing this enterprise upon a proper business basis, it is including in its water rates adequate interest and sinking-fund charges to meet the indebtedness incurred in the establishment of the system.

Five Million One Hundred Thousand Dollars for Chicago bridges was the main item of the bond issue authorized in the election held in Chicago on June 5. The extensive plans of the engineers, which these bonds are to cover, include nine bascule bridges over the Chicago River, in the business district, at a cost of $300,000 to $600,000 each. Seven of these will replace existing bridges, some of which are bascule spans and others center-pier swing spans, and they will eliminate practically all the center piers, thus giving a clear river channel. Two of the bridges will be additional crosings of the main arm of the river, at Franklin and La Salle St. These, with the new Michigan Ave. double-deck bridge (to be built under other arangements) will greatly improve the communication between the north and south districts and reduce the present congestion. Besides these large bridges there will be the construction and reconstruction of a number of smaller structures. The new bridge project is under the direction of John Ericson, City Engineer.

A 72-In. Reflecting Telescope, the largest yet completed, has just been finished by the Warner & Swasey Co., of Cleveland, for the Dominion Astronomical Observatory, Victoria, Canada. This telescope is of equatorial-mounting type, supported at north and south ends by bearings in a direction parallel to the earth's axis. The declination axis to which the tube is attached, at 90°, passes rectangularly through the central cubical portion of the polar axis. The instrument weighs 55 tons and will rest on concrete piers. A precision driving clock moves the telescope in right ascension, through an accurately cut worm wheel 9 ft. in diameter on the polar axis. The telescope is moved from one position to another and is set and guided by seven electric motors. The 72-in. mirror and optical accessories were made by the J. A. Brashear Co., of Pittsburgh. The revolving dome, made by Warner & Swasey Co., is 66 ft. in diameter and weighs 120 tons. It has a double shutter with an opening 15 ft. wide. All movements, including revolution, operation of shutter and wind shield, and control of observing bridge are controlled by electric motor.

Subway Ventilation through Sidewalk Gratings on the Broadway line in New York City has been investigated by Public Service Commissioner Henry W. Hodge. Nearly a year ago, on account of the protest of a large number of property owners against the placing of ventilating gratings in the sidewalks, the Public Service Commission referred the matter to a board of engineers for investigation. The report of that board was abstracted in "Engineering News" of Mar. 16, p. 531. It was to the effect that the ventilation through sidewalk gratings was on the whole the least objectionable of any practicable plan of ventilation. Protests were made to the commission against the adoption of this report, and the matter was referred to Commissioner Hodge for investigation. The Commisioner has recommended the elimination of sidewalk gratings between 29th and 35th St., and between 39th and 46th St. Between 35th and 39th St. it was found impracticable to eliminate the gratings because of the long distance to the nearest ventilating chambers and the difficulty in effectually forcing air over such long distances. Where the gratings are to be eliminated from the sidewalks, they are to be placed in parks and other open spaces along the roadway. It should be noted that this decision relates to points where the subway work is not yet completed and a change in the ventilating system is possible. Commissioner Hodge did not favor any changes in portions of the subway where the ventilating system is already completed.

PERSONALS

H. L. Hudson has resigned as Assistant City Engineer of Laporte, Mich., to engage in construction work in Indianapolis.

John E. George, of Baltimore, Md., has been appointed Assistant to Chairman Zouck, of the Maryland State Roads Commission.

Alexander P. Crary, Assoc. M. Am. Soc. C. E., of New York City has been appointed Resident Engineer on Dock Work in Baltimore, Md., of the Cleveland Dock Engineering Co.

R. C. Brown has been appointed Engineer of Maintenance of the San Pedro, Los Angeles & Salt Lake R.R., a newly created position. His headquarters will be in Los Angeles.

George J. Young, M. Am. Inst. M. E., now Professor of Mining Engineering in the University of Minnesota, has been appointed Professor of Metallurgy in the Colorado School of Mines.

Nathan W. Dougherty, Assistant Professor of Civil Engineering in the University of Tennessee has been appointed to succeed Prof. William Waller Carson as Professor of Civil Engineering.

J. E. Ellms, of Cincinnati, Ohio, has been appointed Temporary Superintendent of the Cleveland Filtration Plant, with a salary of $300 a month. Mr. Ellms will divide his time equally between the Cleveland and Cincinnati plants.

Edgar E. Calvin, Vice-President and General Manager of the Oregon Short Line R.R. and First Vice-President of the San Pedro, Los Angeles & Salt Lake R.R., has been elected President of the Union Pacific System, to succeed A. L. Mohler.

Gustav J. Requardt, Assoc. M. Am. Soc. C. E., Division Engineer, Sewage Disposal Plant, Baltimore Sewerage Commission, has resigned to become associated with the firm of Norton, Bird and Whitman, Engineers, of Chicago and Baltimore. His headquarters will be at 1320 Munsey Building, Baltimore, Md.

A. C. Southern has resigned as County Surveyor and Highway Engineer of Cole County, Mo. It is stated that he will be appointed circuit judge to fill an unexpired term (until the November election) caused by the death of Judge Frank G. Johnson.

Edward M. Stayton, M. Am. Soc. C. E., has been appointed County Surveyor and Highway Engineer of Cole County, Mo. Mr. Stayton studied civil engineering in the Missouri State University, and has had experience as Assistant City Engineer of Independence, Mo., as well as in railway work in Spanish Honduras and in the vicinity of Kansas City.

Charles G. Thornburg has resigned as Assistant Engineer in the Bureau of Water, City of Philadelphia, to accept the position of Resident Engineer at Port Henry, N. Y., for Frank C. Roberts & Co. on the construction of an ore dock for the Lake Champlain & Moriah Railroad Co. Mr. Thornburg graduated from Lehigh University in 1909. For the past year he has had charge of construction of the sedimentation basin at the Torresdale Filters, Philadelphia.

Frederick Clouston Moore, M. Am. Soc. M. E., has established an office at 710 Engineers Building, Cleveland, Ohio, as Consulting and Executive Engineer. He will act as consultant to owners and executives in all matters pertaining to factory or foundry operation, organization, production, equipment and accounting and costs, and will make special investigations, and reports on new manufacturing projects and on the financial, commercial and physical condition of established concerns. He will also give special attention to industrial and engineering problems.

James Flack Norris, who was recently appointed one of the five Tennesee members of the Naval Consulting Board, has tendered his resignation as Professor of Chemistry in Vanderbilt University and will go to the Massachusetts Institute of Technology to take charge of research work and graduate courses in chemical engineering. Dr. Norris is a graduate of Johns Hopkins University. He became connected with the Massachusetts Institute of Technology after his graduation in 1893, rising to the position of Assistant Professor of Organic Chemistry. He was formerly President of the Northeastern Section of the American Chemical Society, and is the author of "Principles of Organic Chemistry" and other treatises.

William Waller Carson, M. Am. Soc. C. E., has resigned as Professor of Civil Engineering in the University of Tennessee on account of advancing years and has been made professor emeritus by the Board of Trustees. Professor Carson is one of the oldest professors of engineering in point of service in the country. He was born in Adams County, Miss., in 1845. He was a member of the Confederate Army and rose from private to sergeant-major. He obtained his engineering degree at Washington College (now Washington and Lee University) in 1860, and from 1877 to 1883 was instructor in mathematics at Davidson College. He became a member of the faculty of the University of Tennessee in 1885. Professor Carson is also a member of the Engineering Association of the South and the Society for the Promotion of Engineering Education.

OBITUARY

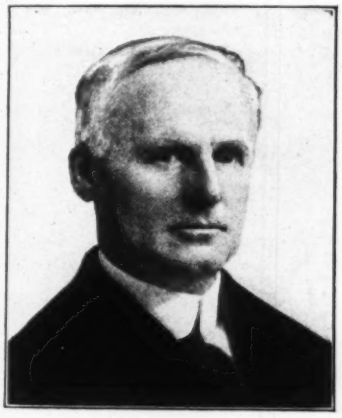
John C. Ryan, a civil engineer, of Rochester, N. Y., died on May 23, at 66 years of age. Mr. Ryan had been prominently known in Rochester for many years.

Elswood Usinger, member of the Gloucester County, New Jersey, Board of Freeholders, a prominent road and bridge builder died on May 31, at 68 years of age. Mr. Usinger was also a member of the Delaware River Bridge and Tunnel Commission.

Francis Rowland Porter, Manager of the Fire Underwriters' Inspection Bureau, of San Francisco, Calif., died on May 19. He was born in Boston, Mass., and went to California in 1882. In 1884 he entered the employ of the Pacific Insurance Union of San Francisco as a fire-insurance surveyor, and in 1885, when the Bureau named "Inspection Bureau of the Underwriters' Fire Patrol" was formed, he was appointed Chief Inspector. A few years later the bureau changed its name to Fire Underwriters' Inspection Bureau.

Edward Russell, one of the best known granite men in the United States, died at his home in Gloucester, Mass., on June 3. Mr. Russell had been identified with some of the largest construction enterprises in this country. He quarried and successfully transported to sea on a lighter specially constructed for the purpose, what is claimed to be the longest single piece of granite on record, used in the construction of the main arch of the Cathedral of St. John the Divine, in New York City. He was 83 years old.

Charles Sooysmith, M. Am. Soc. C. E., Consulting Engineer, died at his home in New York City, on June 1, at 60 years of age. He was born in Buffalo and was the son of the late Gen. William Sooy Smith, of Chicago. He received his civil engineering degree from Rensselaer Polytechnic Institute and spent two years in study abroad, part of the time attending the Polytechnicum at Dresden. In 1879 he was appointed Assistant Superintendent of the Department of Track, Bridges and Buildings of the Atchison, Topeka & Santa Fe R.R. He left that position two years later to join his father in the firm of Wm. Sooy Smith & Son, engineers and contractors. In 1887 he organized and became president of the firm of Sooysmith & Co., contracting engineers, and during the next ten years constructed many important railway bridges in the South and West. He was also chief engineer in the construction of Central Bridge over the Harlem River at New York City. Mr. Sooysmith introduced the pneumatic-caisson method for sinking the foundations of high buildings. In New York City his company erected the following buildings: Manhattan Life, the American Surety, Empire and Washington Life buildings. He also introduced into this country the freezing method for making excavations and greatly improved and developed it, and perfected plans for the application of the process to the construction of subaqueous tunnels. Since 1898 he had occupied offices at 71 Broadway, New York City.



CHARLES SOOYSMITH

Thomas McNeil, Sr., President of the James McNeil & Bro. Co., died on May 28, in his 76th year. He was born in Rutherglen, Scotland, and came to America when eight years old, settling with his parents in Canada, where he remained until 1860, when he went to New York City. During the Civil War Mr. McNeil was employed in the United States Navy Yard at St. Helena Islands, looking after transport vessels. In 1865 he located in Pittsburgh, and with his brother James started in the boiler business, which business was incorporated in 1900 under the present name of James McNeil & Bro. Co. Mr. McNeil was granted several patents in connection with his business and was one of the first manufacturers to advocate and develop riveted steel pipes for large-diameter conduits. He was considered an authority in steel-plate construction work.

ENGINEERING SOCIETIES

SOCIETY OF AUTOMOBILE ENGINEERS.
June 12-16. Summer meeting (cruise on Lake Huron and Georgian Bay). Secy., Coker F. Clarkson, 29 W. 39th St., New York City.

MASTER CAR BUILDERS' ASSOCIATION.
June 14-16. Annual meeting, Atlantic City, N. J. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 14-17. Eighth semiannual meeting, Cleveland. Secy., I. C. Olsen, Cooper Union, New York City.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION.
June 14-21. Convention in Atlantic City. Secy., J. D. Conway, 2136 Oliver Bldg., Pittsburgh.

SOCIETY OF RAILWAY CLUB SECRETARIES.
June 16-17. Annual meeting in Atlantic City. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN RAILWAY MASTER MECHANICS ASSOCIATION.
June 19-21. Annual meeting, Atlantic City, N. J. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION
June 19-22. Annual meeting in Charlottesville, Va. Secy., F. L. Bishop, University of Pittsburgh, Pittsburgh.

TRI-STATE WATER AND LIGHT ASSOCIATION OF THE CAROLINAS AND GEORGIA.
June 21-23. Annual convention at Isle of Pines, S. C. Secy., W. F. Stieglitz, Columbia, S. C.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 27-30. Annual meeting in Pittsburgh. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 27-30. Annual meeting in Atlantic City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

The American Public Health Association will hold its annual meeting in Cincinnati Oct. 24 to 27. The secretary is Prof. Selskar M. Gunn, Boston.

The American Society of Municipal Improvements will hold its 1916 convention Oct. 9 to 13, in Newark, at the Robert Treat Hotel. The secretary is Charles Carroll Brown, Indianapolis, Ind.

The Southwestern Concrete Association was organized at a meeting held in Kansas City, Mo., on May 26. The purpose of the association is "for discussing the various questions arising from time to time in the uses of concrete, and to exchange views as to the best methods to extend and develop its use." The officers are as follows: President, G. B. Appo, publisher of "Portland Cement"; 1st vice-president, Martin Carroll, general contractor; 2nd vice-president, W. F. Fague, with Sunflower Portland Cement Co.; secretary, H. H. Peters, manager "Western Contractor"; treasurer, Chas. A. Stevenson; all of Kansas City, Mo.

The Colorado Association of members of the American Society of Civil Engineers will hold its annual meeting and 77th regular meeting, in Denver, on June 10. An informal dinner will precede the meeting and at the latter the principal speaker will be J. C. Lippincott, Consulting Engineer of the Los Angeles Aqueduct Bureau, whose subject will be "The Construction and Operation of the Aqueduct." The Los Angeles Aqueduct though primarily a water-works system provides for the irrigation of 135,000 acres of land and for the development of a maximum of 120,000 hp. The regular meetings of the association will be omitted during July and August, but the usual Wednesday luncheons will be continued. The secretary is L. R. Hinman, 1400 W. Colfax Ave., Denver, Colo.

Appliances and Materials

Tetrachloride Fire Extinguisher

A type of carbon-tetrachloride hand fire extinguisher is being put out by the H. W. Johns-Manville Co., of New York City, combining the advantages of pump and compressed-air tank units. There is, as a part of the extinguisher, a hand pump by which the air pressure on the liquid can be secured; then a nozzle valve is used to control the stream. It is claimed that this combination has been found of advantage in restricted spaces where there is not room for working the pump close up to the blaze.

• • •

New Turbo Blower

A new turbo blower of capacity ranging from 3,000 to 35,000 cu.ft. of free air per min., at 2½ lb. pressure, has been added to the line of the Ingersoll-Rand Co., of New York City. It is of the single-stage, double-flow type and can be furnished with electric motor, steam turbine, or waterwheel.

The blower unit is of the four-bearing construction featured in all turbo machines of this make. The impeller is of

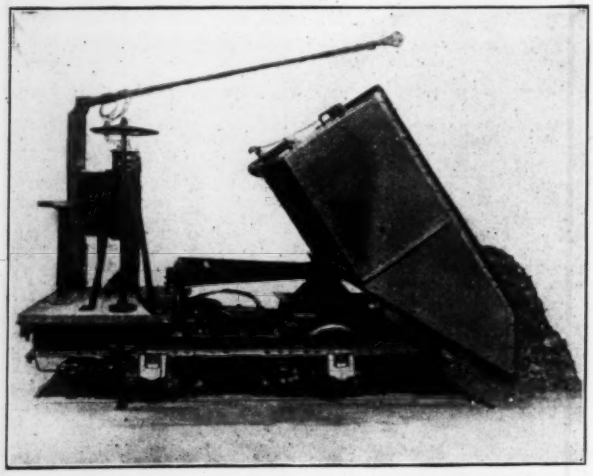
the inclosed double-flow type, the wheel being machined from a solid steel forging. Vanes and covers are of pressed steel. The blower is particularly adapted to such services as foundry-cupola blowing, atomizing oil for oil burners, supplying blast to heating and annealing furnaces, blowing air for water-gas generators, and for pneumatic conveying and ventilating.

Ingersoll-Rand also builds multi-stage centrifugal blowers of capacities ranging from 3,000 to 60,000 cu.ft. of pressure up to 30 lb., and turbo compressors up to 100-lb. pressure.

* * *

Self-Propelled Dump Car

A motor-driven dump car that can be handled by one man is now manufactured by the Orenstein-Arthur Koppel Co., of Columbus, Ohio. The car, which in the accompanying view is shown discharging its load, has the following dimensions: 9



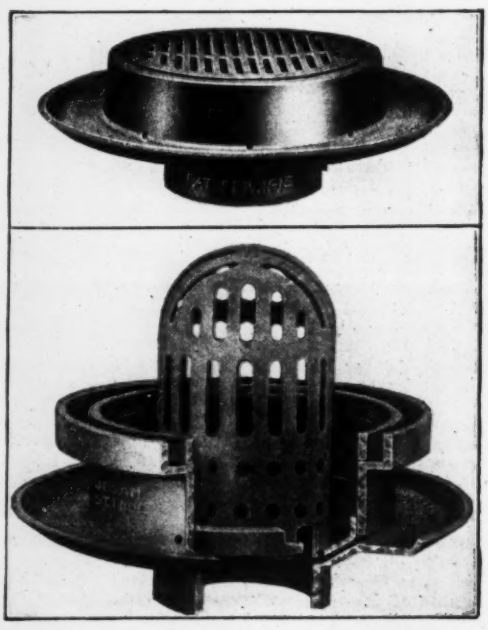
MOTOR DUMP CAR DISCHARGING LOAD

ft. 8 in. by 5 ft. 10 in. in plan by 4 ft. 8 in. high. The capacity is 54 cu.ft. The car is built for any gage from 36-in. to standard, and is equipped with motors for either alternating or direct current.

* * *

Anti-Seeping Roof and Floor Drain

A new type of roof and floor drain head, preventing leakage from around a strainer head down along the drain pipe, has been evolved by the Josam Manufacturing Co., of St. Louis, Mo., the important feature being shown in the accompanying view. This is a wide cup flange to be built in the roof or floor construction, catching all seepage which may occur between the strainer box and the roof or floor surface. Small drain holes lead from the cup into the drain. Various forms of this "Double Drainage Drain" (its trade name) are made in cast iron and brass for wood and concrete roofs, tile floors, etc. Some have variously combined traps and back-water valves, swing joints, adjustable strainers, screw or soil-pipe ends, single and double sediment cups (for catching tar, gravel, etc., on composition roofs), non-tilting gratings, clamps for lead flashing under tile floors, etc. These drains have recently been used in public schools, hotels, hospitals, warehouses, etc., and are accepted for use under the "uniform plumbing specifications of the U. S. Treasury, War and Navy Departments." The prices range from $6.50 for a 2-in. simple drain head to $12 for a 2-in. trapped box, $24 for a trapped box with ball valve, and $28 for an 8-in. roof drain with removable sediment cup.

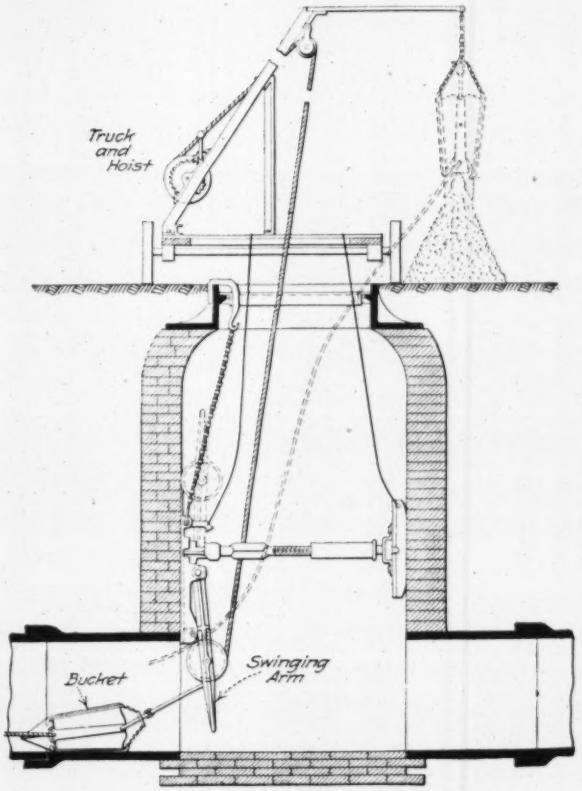


JOSAM PROTECTED ROOF DRAINS

* * *

Sewer-Cleaning Machine

The Kuhlman sewer-cleaning machine, shown herewith, uses an expansion bucket fitted with cutting jaws and operated by two ⅜-in. cables 300 ft. long. The bucket can be drawn through from one manhole to another, or it can be drawn in until it is filled and then withdrawn. In the latter case, when its motion is reversed the cutting jaws close up and prevent the contents of the bucket from falling out. Each cable is operated by a hand-power drum mounted on a wheeled truck, having a gallows frame at the front end, with an arm to project over the manhole opening and handle the bucket in dumping. A special feature is a hinged jack arm placed at the bottom of the manhole to guide the bucket and cables and prevent them from striking and injuring the mouth of the sewer. This arm is pivoted to a brace



KUHLMAN SEWER-CLEANING MACHINE

across the manhole and carries a guide pulley for the cable. Normally it hangs over the mouth of the sewer pipe, but as the bucket is pulled out it engages the arm, which swings to a horizontal position and so carries the bucket out to the center of the manhole. In lowering the bucket, the arm keeps it clear of the sides until the bottom is reached and then swings it into the sewer opening. The device is the invention of John F. Kuhlman, Commisioner of Public Works at Hammond, Ind. It is manufactured by the Champion Potato Machinery Co., Hammond, Ind., and sells for $500, complete.

CIVEN 1916 Chic

Engineering News

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Hill Publishing Company

NEW YORK, JUNE 15, 1916

Price, 15 Cents
Contents, First Page
Advertising Index, Last Page

98½% Floor Service

THIS Kreolite Hex Wood Block Floor on the unloading platform of the Cleveland Builders' Supply Co. is giving 98½% service under the hardest kind of use, as nearly perfect service as any floor can give. Trucking on this pavement is continuous. Loads are heavy and many of the materials and packages dumped on the floor have sharp pointed edges. The floor is also directly exposed to the weather at all seasons in the year. Yet it is practically as good as the day it was laid, and good for thirty or forty years more.

KREOLITE

HEX WOOD BLOCK FLOORS

are ideal floors for heavy, hard service, especially where exposed to moisture, as in loading platforms, basements, foundries and annealing rooms. Kreolite Hex Wood Blocks are made of slow-growing tamarack hearts, impregnated with Kreolite preservative oil. They are proof against decay and practically proof against wear. The irregular "hex" shape allows for expansion, preventing bulging or unevenness whatever the weather conditions. They are easy to truck over, resilient, non-conducting and also comfortable for workmen.

Specifications, plans and estimates gladly furnished. Write to-day for booklet "Modern Factory and Warehouse Floors."

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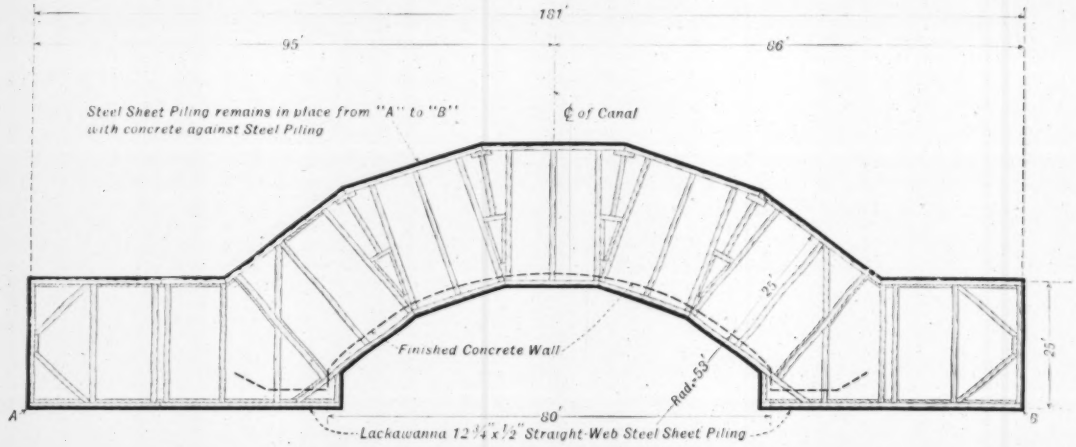
Piling, Structural Timbers, Cross Ties



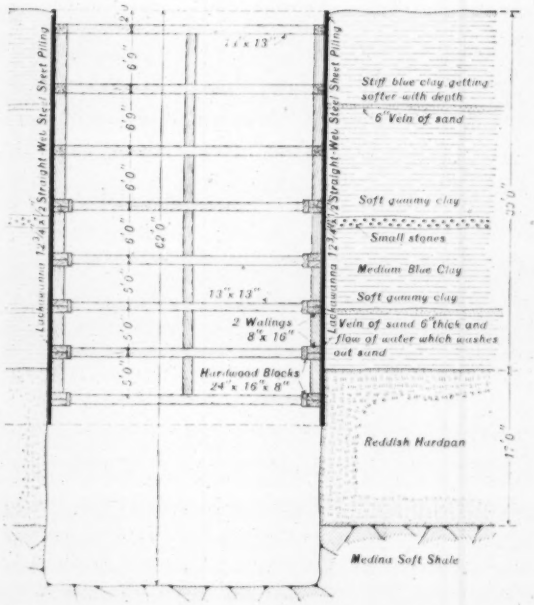
Lackawanna Steel Sheet Piling Cofferdams For Breast Walls of Locks Nos. 2 and 3 of the New Welland Ship Canal

The two locks on the Welland Ship Canal, now being built by Baldry, Yerbaugh & Hutchinson, Ltd. of St. Catherines, Ont. on a $5,500,000 contract are each substantially 80 feet between walls, 800 feet long and 30 feet over the miter sills. The breast walls for each of these locks had to be built within steel sheet piling cofferdams in order that there should be no disturbance of the material on upstream side which has to carry the forebay walls and floor.

The most efficient and economical material for these cofferdams appeared to be Lackawanna 12¼ by ½-in. Straight-Web Steel Sheet Piling driven in 45-foot lengths down to hardpan, and shorter steel sheeting, if found necessary for the remaining 15 feet down to bed rock. The design and general plan of bracing adopted are indicated in the accompanying plan and elevation. The steel sheeting on the front side from A to B (plan) was to be removed and the finished concrete wall exposed, while the steel sheeting on the back and sides was to be left in position permanently.

Both of these cofferdams have now very successfully served their purpose, the excavations being completed and the concrete walls being finished to ground level.

Further details as to the driving and performance of the steel sheet piling will appear in our next week's advertisement, and other large cofferdam work is described and illustrated in our book "Lackawanna Steel Sheet Piling" which will be sent to any managing engineer on request.



LACKAWANNA STEEL COMPANY

General Sales Office and Works: Lackawanna, N. Y.

NEW YORK, BOSTON, BUFFALO, PHILADELPHIA, CLEVELAND, CINCINNATI, CHICAGO, DETROIT, ST. LOUIS, ATLANTA, SAN FRANCISCO

Licensees for the manufacture of Lackawanna Steel Sheet Piling:

For Great Britain and British Colonies in the Eastern Hemisphere, Cargo-Fleet-Iron Co., Ltd., Middlesborough, England. For France, Italy, Spain, French Colonies and Protectorates, Italian Colonies and Spanish Colonies in the Eastern Hemisphere: Cie Des Forges & Acieries de la Marine d'Homecourt, Paris, France.

Engineering News

VOLUME 75 JUNE 15, 1916 NUMBER 24

Building Power House and Dam on Sand Foundation

SYNOPSIS—Power house and 1,000-ft. concrete dam built upon the deep sand bed of the Wisconsin River. Sand confined between lines of steel sheeting and covered with loose rock. Wood piles driven within the inclosure. Special protection against wash at downstream side of dam. Electric industrial railway, with remote control of movements of the cars used for handling material. Construction plant and methods are described.

The hydro-electric plant of the Wisconsin River Power Co., at Prairie du Sac, Wis., has the two specially interesting features of being built upon a deep sand foundation and having the crest of its dam formed by a series of large Tainter gates. The work comprises a power house 329x145 ft. at the west side of the river channel, a hollow concrete dam 1,000 ft. long and an earth embankment extending 1,700 ft. beyond the east end of the dam. Between the power house and the dam are a log chute and a navigation lock 35x170 ft. Fig. 2 is a general plan.

The bed of the Wisconsin River at this point is a deep stratum of sand, changing to heavy gravel and boulders on each side of the channel. Borings made to depths of over 50 ft. failed to show any indications of rock or hard material. The west bank is high and steep, and the power house is built close against it, but low ground on the east side necessitated the construction of the earth embankment.

The power house is of reinforced concrete, supported on round piles spaced 4.5 ft. c. to c. The entire area, 329x145 ft., is inclosed with steel sheetpiling, which is 50 ft. long in the upper line, 15 ft. in the lower line and 40 ft. in the line between the power house and lock. An intermediate line of 15-ft. sheeting was driven about 50 ft. below the upper line.

The draft tubes are of special design, each unit having two separate draft tubes extending to within 25 ft. of the downstream face of the power house. At this point they are joined and continued as one opening. The draft tubes were molded in the concrete, and steel forms were used to produce the desired surface. As a considerable portion of the concrete surrounding the draft tubes was placed during winter weather, the steel forms afforded an excellent opportunity to build fires inside and keep the temperature above freezing point.

The superstructure consists of a brick building with two concrete floors. It is fireproof throughout, the windows having steel frames and sash, with wire-inserted glass. The entire structure rests upon a foundation of sand and is supported on piles; but it is interesting that after two years of operation no settlement cracks are seen.

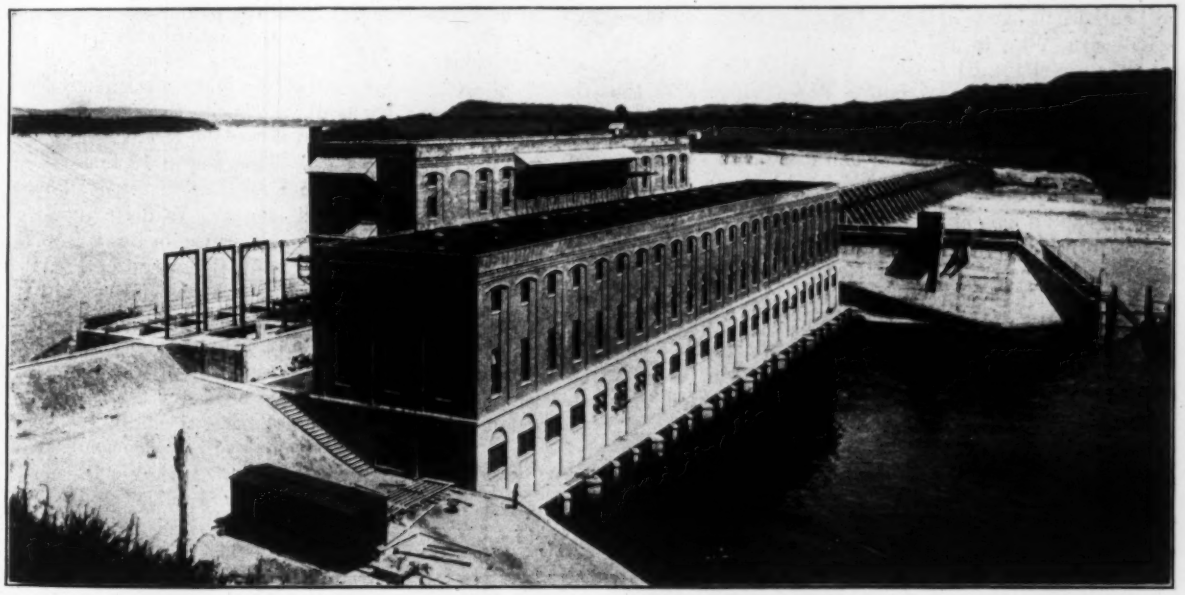


FIG. 1. POWER HOUSE, LOCK AND DAM AT PRAIRIE DU SAC, WIS.

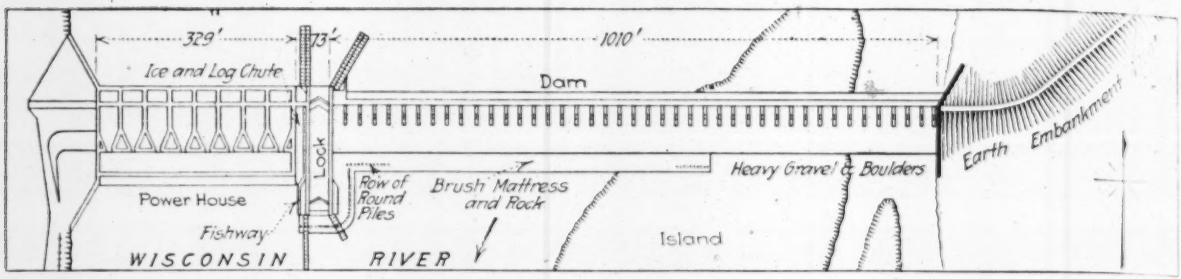


FIG. 2. PLAN OF HYDRO-ELECTRIC PLANT OF THE WISCONSIN RIVER POWER CO., AT PRAIRIE DU SAC, WIS.

The turbine chambers are formed of reinforced concrete, with 3-ft. walls separating the various chambers. A 3-ft. wall also separates the generator room from the penstocks. Water is admitted to each turbine unit through three openings between concrete piers. Each opening is 10.5 ft. wide and is controlled by a double-leaf steel gate. The gates are operated from a gantry crane that may be moved the entire length of the power house.

Each turbine unit consists of four 64-in. wheels on a single line of horizontal shafting. The turbines are designed to operate under a head varying from 22 to 34 ft., and under a maximum head each unit will develop 4,000 hp. The shafts are extended through the bulkhead and connected to 2,500-kw. generators. There will be eight generator units. Six of these are installed, two furnishing 60-cycle and the others 25-cycle current (see Fig. 3).

A transmission line runs to Portage, 24 mi., where it connects with the existing 25-cycle line extending from the Southern Wisconsin Power Co.'s hydro-electric plant at Kilbourn, Wis., to Milwaukee. Another transmission line runs direct from Prairie du Sac to Madison, 28 mi., and two short lines serve half a dozen villages in the neighborhood.

Hollow Dam Founded on Sand

The dam is of the hollow concrete type, with interior buttresses and a long apron on the downstream side. The crest is formed by a row of Tainter gates 14x20 ft. The buttresses are spaced 8 ft. c. to c., and between them are two lines of reinforced-concrete struts. Each third buttress is 4 ft. thick and is carried up as a pier to support the gates and operating platform. The intermediate buttresses are 18 in. thick and are entirely within the dam. All the buttresses have openings 3x6 ft. connected by a concrete-slab footwalk for inspection purposes.

The sand beneath the dam is confined between two lines of steel sheetpiling—a line of 50-ft. sheeting under the upstream face and a line of 30-ft. sheeting under the end of the apron. A filling of boulders and loose rock is placed inside the dam, and a clay and gravel fill is placed above the upstream line of sheeting. Special provision is made against erosion below the end of the concrete apron. A heavy mat 30 ft. wide is laid against the downstream sheeting, at a depth of about 15 ft., and is covered with a fill of heavy rock.

The construction of this work during severe winter weather and with at least one large flood besides other periods of high water was a serious proposition. The dam was completed in January, 1915, and since then it has carried floods with 4 or 5 ft. of water over the crest. Investigation after this showed no material change in the conditions within the dam, and no appreciable settlement or displacement of the rock fill below the apron.

Foundation Piling

The first work was to inclose the power-house site with a coffer-dam and put in the foundation piling and the concrete substructure. The lock and fishway were built next. Then the east end of the dam was undertaken, being built in the dry across the head of the island.

The main part of the dam across the river channel was the last section of the work. This was in 10 to 16 ft. of water, and the flow of the river was diverted through the power house. The first step was to drive the steel sheeting on the downstream side, with its top 2 to 3 ft. below low water level. This is 30 ft. long, except in the heavy gravel at the east end, where its length is 20 ft. Then the 50-ft. steel sheeting on the upstream side was driven, its top being from 3 ft. above to 1 ft. below low water. The latter sheeting was followed closely with timber piles on the inside, these being for the permanent work, but serving also to brace the sheeting.

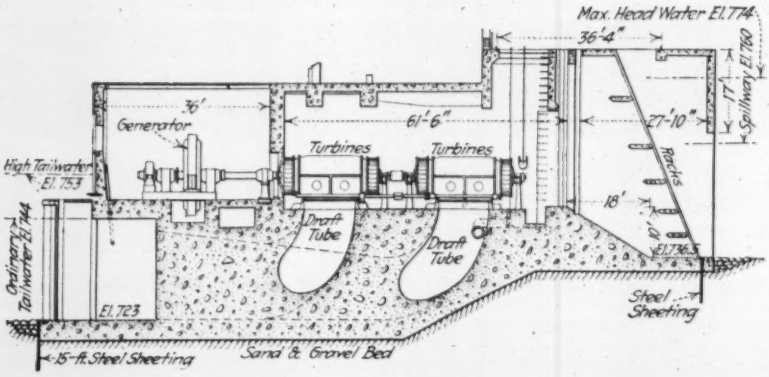


FIG. 3. SECTION THROUGH POWER HOUSE BUILT ON SAND FOUNDATION

The steel sheeting was commenced at both ends, and the closure was made with very little trouble, the sheeting being spread by jacks to admit the closing pile. The next step was to drive the remainder of the timber foundation piles. These were 30 to 35 ft. long in the deep sand and 15 ft. long in the heavy gravel encountered at the ends of the dam. Different designs of interlocking steel sheetpiling were used.

Both the steel and wood piles were driven with steam pile hammers assisted by water jets. It was hard work driving the wood piles in the sand in

spite of the use of water jets. To examine the efficiency of the sheeting, a test pit 12 ft. diameter was formed by driving 20-ft. steel piling. Round piles were driven within this, and the material was then excavated to a depth of 15 ft. The sheeting was found to be in good condition, while the round piles were broomed, having been subjected to unusually hard driving.

The sheeting and foundation piles being in place, a centrifugal pumping plant was used to pump sand into the inclosed space, and on this was dumped loose rock making a 2-ft. mat to protect the fill from wash. Some small rises occurred in the river during this portion of the work, but there was no serious flooding.

Concreting the Dam

The concrete work was then commenced, being done in sections 50 to 60 ft. long, inclosed by sandbag coffer-dams to exclude both the headwater and backwater. The first part of the concreting included the cap over the upstream sheeting, the footings for the buttresses (to a height of about 3 ft.), and the entire width of the apron, including the cap over the downstream sheeting.

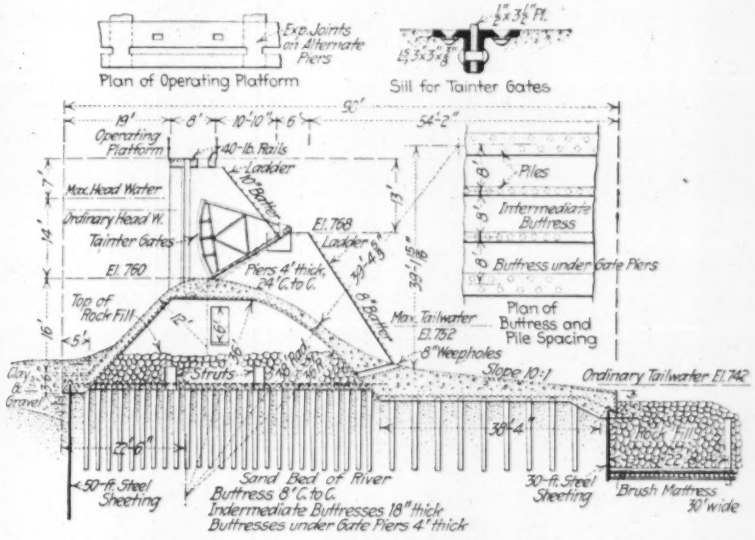


FIG. 4. SECTION THROUGH HOLLOW CONCRETE DAM BUILT ON SAND FOUNDATION: WISCONSIN RIVER POWER CO.

This being completed for the length of the dam, sections of similar length were taken and the buttresses carried up to the full height of the dam. Then the upstream face or blanket was placed, next the downstream face, and finally the crown. For each of these several stages the work was done in lengths of 50 to 60 ft. The next stage was to carry up the piers to full height and connect them with the concrete walk.

Before closing the dam by placing the top, or crown, a 3-ft. bed of boulders and loose rock was placed inside to increase the stability and to weight the inclosed sand fill of the foundation. Finally clay and gravel was filled in along the upstream face, where the material had been washed out around the top of the sheeting. This will remain undisturbed and may be increased somewhat by sediment, but there is so little current in the pool that this accretion will be slight. The downstream protection of the apron is described later.

Dovetailed grooves form bonds in the vertical joints between different sections of the concrete work. In building up the buttresses the top surface, for the horizontal joints, was made with rectangular recesses or projections. The latter had the advantage of not tending to collect mud or dirt, which would have to be cleaned out of recesses before starting the next section of the buttress. Wood forms were used for all the work except the upper part of the piers and the bridge or platform between the piers. The piers have grooves for stop-logs, and timbers were placed in these to raise the head 5 or 6 ft. until the gates were installed.

The bridge or working platform is 1,000 ft. long, and in order to provide for expansion and contraction movements it was made in lengths covering two spans. The piers were carried up to full height, and the platform was built after the concrete had set. Each two-span length has its ends resting on iron base-plates on the piers, but no attempt is made to prevent a bond over the middle pier.

The concrete was made with pit gravel. This was not washed or graded, but was passed over a bar screen with 3-in. openings in order to remove the larger stones, which were used afterward for the fill inside the dam. The mix was 1 : 7 for mass concrete, 1 : 6 for reinforced concrete, and 1 : 5 for some of the small pieces of work. Much of the concreting was done during the winter. The water was heated, but no salt was used, and the gravel was heated by coils of steam pipes. The 50-ft. section of work was covered by canvas sheets about 30 ft. square, supported on frames of 2x6-in. timbers, and salamanders were kept burning on the inside.

The gravel pit was ¾-mi. from the east end of the dam, and the gravel was loaded by a Thew steam shovel into 3-yd. side-dump cars on tracks of 3-ft. gage. These cars were electrically operated, as noted later. The concrete mixing plant was located at the east end of the hollow dam and had two Cube mixers of 1¼-yd. capacity. The gravel cars ascended an inclined trestle and dumped automatically into a 12-yd. hopper. From this the gravel was fed to a measuring hopper (for one batch). This was at the level of the cement storage house, and the cement was placed in the hopper, which then delivered the charge by a chute to the mixer. The concrete was discharged into an elevator bucket, which dumped into a hopper (with valves) in a tower from which it was spouted to the concrete cars. In this way the work proceeded very systematically, there being one batch in the mixer, one in the elevator bucket and a third in the tower hopper.

When the 12-yd. hopper was full, the cars dumped the gravel upon a stockpile, from which it was delivered to the hopper as required by a derrick and bucket located near-by.

The concrete cars were steel hoppers of 1¼-yd. capacity, with a discharge chute in one side, near the bottom. These were handled in 3-car trains, or 4-car trains when both mixers were working. Each train was handled by a motor car with 15-hp. motor.

The trestle across the upstream side of the dam served for the concrete trains, passing places being shifted as required. The cars on the trestle dumped the concrete into steel chutes. These were of V-section with rounded bottom, as in this form there is less tendency of the coarse material to segregate and run along the bottom of the chute than in chutes of semicircular section.

The general storage yard was on the west bank, material being brought in on cars over a spur track a mile in length. From this yard all material was distributed by the cars of the remote-control system.

Electric Industrial Railway

The gravel cars and concrete trains were operated on the Woodford remote-control system (see *Engineering News*, Oct. 21, 1909). Each gravel car (and similar car acting as a locomotive for the concrete trains) had a 15-hp. motor. On the line from the gravel pit there were some short grades of 6 to 7%. In descending the grade, a trip caused the motor to act as a generator, returning current to the line and thus serving to brake the car. At the foot of the grade another trip restored the apparatus to its normal working condition.

An operator in a tower at the mixer controlled the movement of the gravel cars and concrete trains within a certain distance. Another tower at the gravel pit controlled the terminal movements of the cars, and a third tower at an intermediate point controlled the movements between the pit and the mixer plant. A fourth tower near the west end of the dam provided for control of the concreting trains when the work was too far distant for convenient control by the operator at the east end.

Navigation Lock

The river being nominally navigable, the War Department required the provision of a lock. This is 35x170 ft., with a lift that reaches the exceptionally high maximum of 34 ft. This is all built of the 1 : 7 concrete. The gates are of steel, of the horizontally braced type, operated by steel arms driven by an electric motor.

During the construction of the work notice was received from the Government authorities to provide for the passage of a fleet of steel barges that had been built at Green Bay, Wis. At this time the larger part of the dam was above water and the river was at a high stage, with the greater part of the flow going through the power house, while the gap between the completed work and the lock had been closed with stop-logs and steel beams. The passage was delayed until the water had subsided a little, and the stop-logs and beams were then pulled out. This gave a passage 35 ft. wide, in which the water had a drop of about 6 ft. For running the dam each barge had four men handling two sweeps, or long oars, one at each end. All made the passage in safety.

Brush Mattress and Rock Fill

To prevent wash and erosion at the end of the concrete apron by eddies and backlash, a brush mattress 30 ft. wide is placed beyond the apron and covered with heavy rock filling. The river bed was excavated and the mattress placed 10 to 15 ft. below the top of the concrete.

The mattress is composed of mats about 30x31 ft. Local willows were cut and put up in 9- to 12-in. bundles, tied with No. 10 wire. These were hauled to the mattress-making platform, having inclined skids 5 ft. apart. Across the skids were laid poles 5 ft. apart, and the bundles or fascines were placed upon these, followed by a second layer of bundles at right angles to the first. A row of poles 5 ft. apart was placed on top and the whole mass wired together tightly. A wire selvage was also formed around the edges.

The mattresses were launched from the skids and floated into position. The sand and gravel had been excavated to a depth of 10 to 15 ft., and the mats were sunk in place by stone thrown from barges. Near the downstream side a continuous line of 30-ft. round piles was driven through the mat. The piles stood about 8 to 10 ft. above the mattress and served to retain the fill of large loose rock which was dumped upon the mattress to a level with the top of the concrete apron. On the heavy gravel at the east the mattress and the line of piling were omitted, but the rock fill was continued.

Earth Embankment

Beyond the east end of the concrete dam extends an earth fill or embankment 1,700 ft. long and from 1 ft. to 25 ft. high. The top width is 8 ft., with side slopes of 1 on 2. For the first 100 ft. from the dam this has a cutoff of 10-ft. sheetpiling, with wood sheeting extending within 10 ft. of the top of the embankment. Beyond this the cutoff is of wood sheeting 10 ft. deep except that near the extreme end it is replaced with a 3-ft. puddle wall 5 ft. deep. Where the steel and wood sheeting are used in combination, the lower end of the latter is driven about a foot below the top of the former and on the downstream side. A line of clay puddle is then placed along the upstream side of this horizontal joint.

The fill is of earth and was placed partly by dump wagons and partly by small dump cars. A considerable portion was placed also by wheelbarrows, this being done to keep the men employed and thus maintain the organization at times when other work was stopped by high water. The upstream slope is paved with riprap.

Engineers and Contractors

The plant was designed by and built under the direction of D. W. Mead and C. V. Seastone, of Madison, Wis., as Chief Engineers for the Wisconsin River Power Co. R. G. Walker was Resident Engineer in charge of the construction.

The contractor for the entire construction of the dam, power house and lock, including the placing of the steel Tainter gates and the lock gates, was James O. Heyworth, of Chicago. The Tainter gates were built by the Lakeside Bridge and Steel Co., of North Milwaukee, Wis. The steel gates for the lock were built by the Federal Bridge Co., of Waukesha, Wis. The turbines and generators were built by the Allis-Chalmers Co., of Milwaukee, Wis.

Machines for Spreading Rock Dust have been developed by the Bureau of Mines. The experiments of the bureau have shown that by spreading a layer of rock dust over the coal dust in bituminous coal mines the risk of dust explosions is reduced. In the first experiments with rock dust finely pulverized limestone was used, 75% passing a 100-mesh sieve. Later experiments showed that rock ground by a hammer crusher sufficiently fine to pass a ¼-in. slotted screen was practically as efficient as the fine dust and much less costly to prepare. In the original treatment of mine passages the rock dust was spread by hand, but after a time a new layer of coal dust settles over the rock dust and renewal of the rock layer is necessary. This can best be done by a blowing machine. A machine developed by the Bureau of Mines for this work uses air from a pressure blower at about 2 lb. per sq.in. pressure.

FIGS. 1 TO 3. EXTERIOR AND INTERIOR OF THE MILLTOWN, N. J., PUMPING STATION

Automatic Water-Works for a Small Town

By Clyde Potts*

The increase in the population of the borough of Milltown, N. J., from 560 in 1900 to 2,500 in 1912 found the town with neither water-works nor sewers. Water was taken from shallow wells, and outdoor privies were in common use. Plans were drawn by the writer for complete water-supply and sanitary-sewerage systems. The following notes on the water-works should be of interest to engineers dealing with small-town problems, since the service is by pumping, but is entirely automatic and requires only a small amount of attention.

About 5.6 mi. of pipe—all cast iron of hub-and-spigot pattern, American Water-Works Association Class B—was required. The sizes were as follows: 4 in., 2,482 ft.; 6 in., 18,053 ft.; 8 in., 1,912 ft.; 10 in., 7,223 ft. The cost of this system complete, including 85 valves and 52 hydrants, was $23,922, making $4,270 per mile.

The supply consists of a filter gallery laid along the edge of the hill and leading to a large storage well. In addition to the filter gallery two wells 6 ft. in diameter, made of interlocking steel sheet piling, were driven through the gravel to a shaly rock. These wells also flow into the storage well.

The filter gallery is some 500 ft. long, is 6 ft. wide and 6 ft. deep. The sides are built of hollow tile along the lower 4 ft. The groundwater enters the filter gallery through the sides and through the bottom, coming up through the gravel. This gallery has a reinforced-concrete roof and is provided with manholes at various points to permit the attendant to enter it for the purpose of cleaning. The storage well is 30 ft. in diameter and 18 ft. deep. Water is taken from this storage well by a Deane 10x10-in. triplex pump operated by an electric motor. A similar gas-engine unit is installed (Fig. 3). The water is pumped through a 10-in. pipe laid through the main street of the borough to a 90,000-gal. tank elevated on a 75-ft. tower.

The electric pump is automatic in its operation, the electric motor being controlled by a water-pressure gage on a special electric switchboard. The electric energy used is from the town lighting mains—two-phase alternating current at 60 cycles and 220 volts.

When the water in the standpipe falls below a certain point, the reduced pressure on the pressure gage at the pumping station closes a switch, which starts the electric pump in operation, and water is pumped from the storage well into the standpipe until it reaches a predetermined level, when the pressure gage cuts off the current at the switchboard and the pump stops. The control secured by this pressure gage is so delicate that the opening of a hydrant at any place in the main part of the borough reduces the pressure a sufficient amount so that the electric pump starts. In the event of a fire in the borough not only is the water in the standpipe available, but the opening of a hydrant by the firemen immediately starts the electric pump at the pumping station, and the entire 90,000 gal. of water stored in the storage well also becomes available through direct pumping.

The cost of the wells and supply was $6,200. The cost of the pumping station, including the electrically driven pump and gas-engine auxiliary, was $7,650; and of the standpipe and tower complete, $5,800. With the cost of the pipe system before mentioned, this makes the total construction cost of the water system $43,572.

The plant is automatic in its operation and requires very little attention. The superintendent of the water plant, who also has charge of the sewer system, visits the plant daily for purposes of inspection and oiling. The

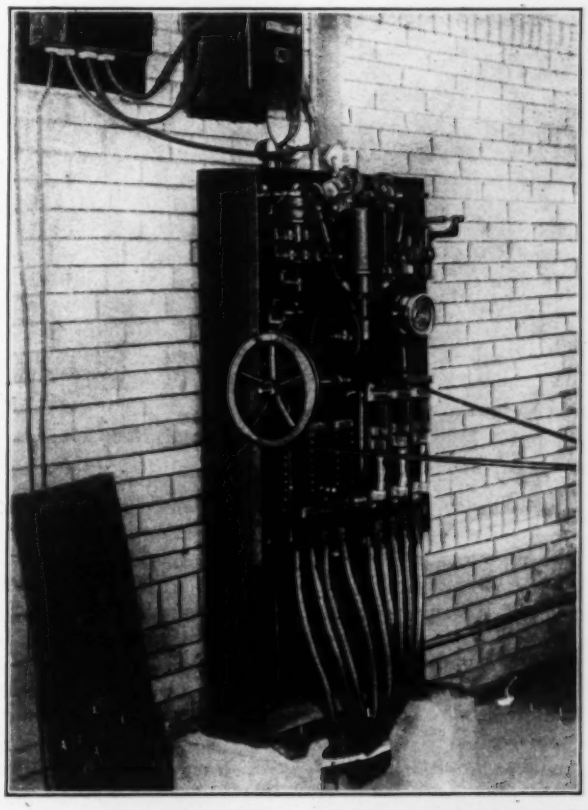


FIG. 4. AUTOMATIC ELECTRIC PRESSURE REGULATOR

*Consulting Engineer, 30 Church St., New York City.

cost of pumping since the plant has been in operation, from Apr. 1, 1915, has been a trifle under $14 per million gallons, exclusive of superintendence.

Since the most unusual feature of this plant is its automatic starting and stopping device, a more detailed description of this controller may be of interest. It is known as the Whittingham motor-driven type, having a double-pole magnetic main-line switch, double-pole no-volt relay sylphon-pilot pressure regulator, three-pole switch and fuses, pressure gage and a switch to permit hand operation independently of the automatic control.

The device is distinctive in that, while it is of the current-limiting type and absolutely prevents the motor from being started on an overload, it also provides for cutting out the resistance if the motor starts and in this respect is unlike series current-limiting controller devices. The resistance, instead of being cut out as is customary on a comparatively few steps, is cut out in 24 graduated steps at an adjustable speed, which once set is unchangeable, obtained directly from the motor through a worm gear magnetically clutched to the resistance arm, resulting in absolute freedom from arcing and from changes in timing. The resistance is of a sand-packed tubular type, mounted below the line of panel, leaving all back wiring exposed. This back wiring is of fireproof insulation with soldered lugs at all connecting points. The period of cutting out of the resistance, or reaching full speed, is considerably over 1 min. in this case, which is highly desirable on a triplex pumping engine of this size, where it is especially needed to keep down the inrush of current.

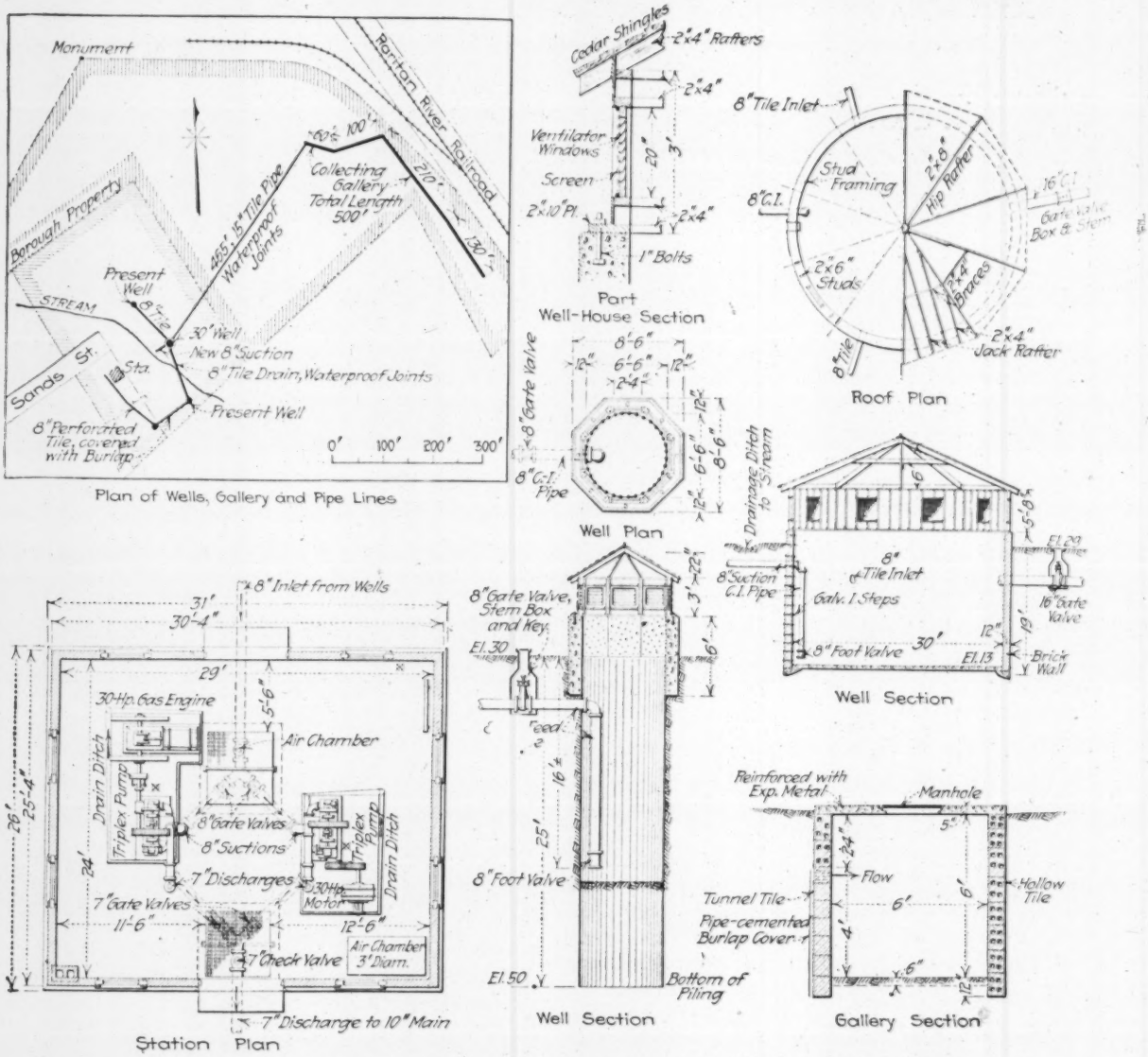


FIG. 5. DETAILS OF MILLTOWN FILTER GALLERY, WELLS AND PUMPING STATION

At full motor speed but two magnets are energized, and this detail differs materially from most controlling devices for the purpose. There is absolute freedom from noise and heating, such as are frequently encountered where a large number of solenoids are called upon to cut out the resistance in successive steps.

This controller not only provides protection against an overload, but also against the blowing out of a fuse, as the relay operated by the pilot-pressure regulator is across one phase, while the magnetic main-line switch is across the other. Therefore, it would be impossible to close the main-line switch, which is fed through the relay contacts, if either phase opens.

FIG. 1. VERY SANDY ROAD ON WHICH GRADERS ARE HAULED BY TRACTOR

In service the regulator is intended to stop the pump at a certain predetermined level about 10 or 12 ft. above the low level at which it starts; but owing to the frictional head, it is found that the opening of a hydrant will start the pump at any time, although the tank may be completely filled. This eliminates the necessity for the use of a hand-operated means for starting the pump independently of the fall in pressure and results in the pump starting immediately in case of fire, thus materially increasing the reserve capacity available in the storage tank.

The contractor for the water-works was the Suburban Engineering Co., New York City; the automatic controller was built by the Automatic Switch Co., New York City.

Tractor with Ball Bearings in Endless Tread

The "Yuba Champion" tractor, having three wheels—the two rear wheels being of the endless-track or caterpillar type—was developed about a year ago by the Good Roads Machinery Co., Kennett Square, Penn. The machine is built in two models. Model 12 develops 20 hp. as a stationary plant, and 12 hp. at the drawbar. It is 14 ft. 7 in. by 69 in. in plan by 57 in. high and can be turned in a width of 15 ft. It has two speeds: 3¼ mi. per hr., and 2 mi. per hr. The total weight is 7,600 lb., of which 6,000 lb. is on the rear wheels. The motor horsepower is 35 to 40. Model 18 develops 25 hp. as a stationary plant, and 18 hp. at the drawbar. It can be turned in a space 15½ ft. wide. Its speeds are ¼ mi. higher than in the case of the other model. The total weight is 8,900 lb., with 7,400 lb. on rear wheels. The motor horsepower is 55 to 60.

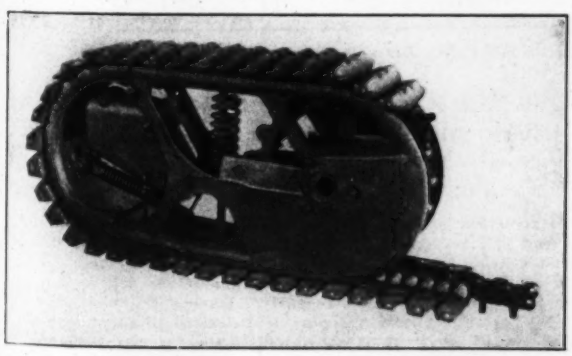


FIG. 2. BALL-BEARING CONTINUOUS TREAD

The distinctive feature of this tractor is the ball-tread traction. The endless track runs on two sets of ball bearings. The maximum wear comes on the balls, which are easily replaceable. In addition to the low friction of this type of bearing, the track is not subject to being thrown off even on side-hill work. The tread can be extended by angles bolted to each alternate tread shoe, which widens the track to 30 in. In Model 12 the normal tread width is 15 in. and the bearing area is 1,080 sq.in., the pressure per square inch on the tread being 5½ lb. In Model 18 the tread width is 17 in., the bearing area 1,632 sq.in., and the pressure 4½ lb. per sq.in. The tread links are of manganese steel.

A distinctive feature is the use of an independent clutch on each tread, which enables the operator to reverse one tread while the other is moving forward, making very short turns possible.

Water Levels of Ocean and Gulf—The United States Coast and Geodetic Survey has recently undertaken to determine the difference in the mean level of the water surfaces of the Atlantic Ocean and the Gulf of Mexico. A representative of the bureau has been sent to Florida to carry a line of precise levels between the tide gages at Fernandina and St. Augustine, on the Atlantic Coast, across the Florida peninsula to tide gages on the Gulf coast. This work should clear up the controversy as to which body of water is at the higher elevation. Another benefit that will result from this line of precise levels will be the establishment of many bench marks of a substantial character whose elevations above sea level will be determined. These can be used by surveyors and engineers who work in the territory crossed by this line of levels.

The Slide-Rule Replaced by a New Computer

By Yu Wang*

Based upon the behavior of a pair of movable parallel lines, a new computing device has come into existence. It has various forms, among them the "Z" Computer, the Computing Board and the Wang Precision Computer.

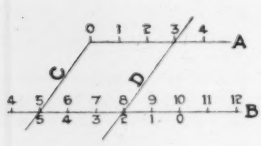
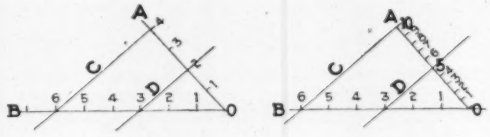


FIG. 1. ADDITION OR SUBTRACTION BY PARALLEL SCALES



FIGS. 2 AND 3. PRINCIPLE OF MULTIPLICATION AND DIVISION IN TWO FORMS

The methods by which these instruments are able to obtain mathematical results are nonlogarithmic; consequently, the instruments do entirely away with the slide, the runner and the movement of scales.

The principle of the instrument is very interesting. One of the parallel lines is to swing over scales, while the other is to move parallel to the first by separation of a parallel ruler. When the movable parallel lines operate on parallel scales, as shown in Fig. 1, addition or subtraction takes place. When line C is swung to point 5 on scale B, line D will indicate 8 if moved to point 3 on scale A and kept parallel to C. Thus we obtain $5 + 3 = 8$, as shown. But if scale B is enumerated reversely, as shown under the line, the whole process becomes subtraction and the figure 2 instead of figure 8 is read; $5 - 3 = 2$, as shown.

When the movable parallel lines operate on a pair of intersecting scales started from the same origin, they will cut ratios and proportions, as in Fig. 2. If line C cuts 6 on scale B and 4 on scale A and the movable line D, parallel to C, is moved to cut 2 on scale A, a proportion will take place; thus, $4:6::2:3$. But if we hinge line C at 10 instead of at 4 (Fig. 3), the proportion becomes either multiplication or division, because $4:6::2:3$ is changed into $10:6::5:3$, or $5 \times 6 = 30$, or $30 \div 6 = 5$.

Again, if we multiply or divide the enumeration on scale B by a common number, the same theory will hold true while the number of figures in the reading is either increased or decreased. For instance, if we multiply scale B by 5 so that the point 6 will be enumerated 30 from the origin, the point 3 will be naturally enumerated 15, and more figures are obtained in the reading. By such multiplication of scales a precision computer is made, to compute more figures than the ordinary slide-rule, three or four figures by scale and four or five figures including estimation.

Besides these results the chief advantages of the instrument are its low cost and the possibility by clever combination of scales to facilitate the calculation of complex problems, eliminating settings and readings, which the slide-rule in many cases cannot do. The Computing Board (Fig. 4), made specially for such purpose, has logarithmic and trigonometric scales, scales of powers and roots, etc., besides the simple addition and multiplication scales.

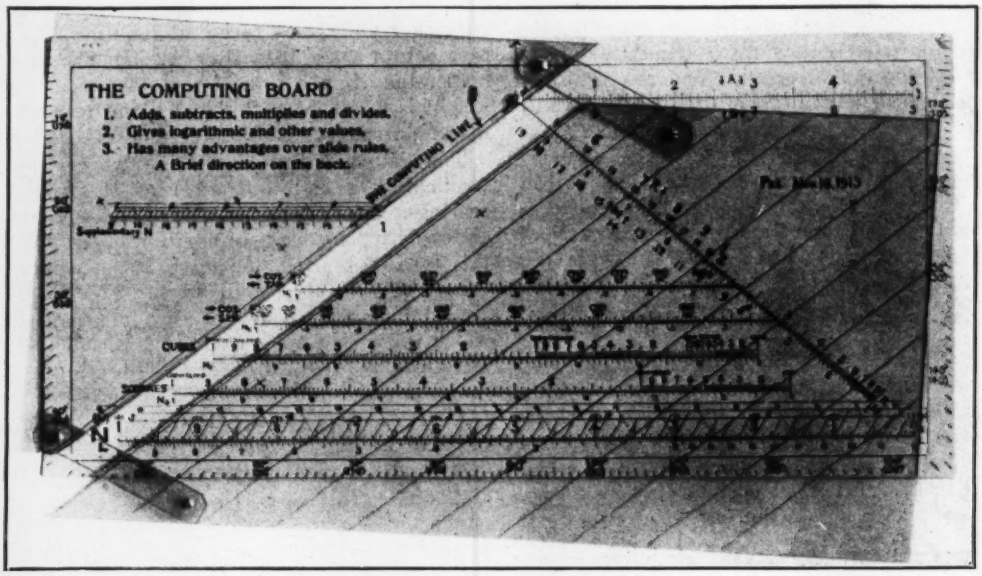

THE COMPUTING BOARD
1. Adds, subtracts, multiplies and divides.
2. Gives logarithmic and other values.
3. Has many advantages over slide rules.
A Brief direction on the back.

FIG. 4. THE WANG COMPUTING BOARD

This kind of instrument was invented by the writer, a Chinese, whose primary patent on such instruments was granted Nov. 16, 1915.

*President of the Scientific Devices Co., 2 Rector St., New York City, and inventor of mathematical instruments.

Extraction of Grease from Sewage at Bradford, England, by the use of niter cake instead of sulphuric acid is under consideration as a war measure. A visit to the sewage works was made by representatives of the explosives department of the Ministry of Munition recently. During the visit it was stated that the munition department desired to encourage the adoption of niter cake as a substitute for sulphuric acid wherever possible, the niter cake to be shipped from the Government factories to places of use.

Concrete-Capped Sheetpile Dam for Erie Canal

By Emile Low*

As noted in *Engineering News*, Jan. 13, 1916, p. 94, the eastern end and part of the sluiceway of the New York State dam across Tonawanda Creek, in Tonawanda, N. Y., was washed out on Jan. 7, 1916, by high water. As this dam regulates the western or the Lake Erie level (Buffalo-Lockport) of the Erie Canal, it was necessary to make immediate repairs, in order not to interfere with the regular canal navigation, which usually opens May 15 of each year. It was decided that a new dam, the essential features to be two rows of steel sheetpiling, capped with concrete, would be the quickest method of construction, as well as the most economical.

To give the least interference while building, and to avoid obstructions and débris of the old dam, the location of the new dam was fixed a short distance above the old one, which was a timber structure, originally built before 1825. It was first proposed to build the new dam on a curve, with a radius of about 300 ft., but this was modified before construction and it was built in two straight parts corresponding to the tangents of the original curve and forming an angle in the center of the stream.

The dam as built consists of two parallel rows of Lackawanna straight-web steel sheetpiling driven 12 ft. apart, the length of the piling ranging from 25 to 35 ft. The tops of the piling are secured against spreading by a reinforced-concrete top, and against overturning by a diagonal system of bracing, consisting of 1¼-in. round steel rods which also tend to stiffen the structure. It is further strengthened by riprap and gravel backing and filling.

The rods leading from the top of the upper row of sheetpiling to the lower row are spaced 10 ft. c. to c., while the reverse rods are spaced 5 ft. c. to c., each rod being of two pieces fitted with a turnbuckle for regulation. The lower ends of the rods were secured to the piling by a nut with a ½x5-in. washer. As the point of connection was from 8 to 10 ft. below water level, the rods were attached to the piling before this point was driven below water level and the driving continued with the rod in place. The upper piece of the rod with its bent end was then hooked into a drilled hole and the rods adjusted for length by the turnbuckle.

FIG. 2. LOOKING NORTH ACROSS NEARLY COMPLETED DAM

The space between the two rows of sheetpiling was filled with Niagara River gravel and sand mixed and a concrete cap placed which formed the crest of the dam. The original plan contemplated a cap with a convex top and straight bottom. This was modified by making the top level and the bottom concave, in other words, turning it upside down, the area of the reversed section remaining about the same. The dam being a submerged weir, the change gave a lower crest elevation and a consequently greater discharge, which in flood times reaches 21,000 sec.-ft. The change was also necessary on account of the water level, the elevation of which made the original construction impossible except inside of a water-tight cofferdam. The ends of the dam impinge against bulkheads built of Lackawanna steel sheetpiling, the ends of which may be noticed in the foreground in the view in Fig. 2.

*745 Lafayette Ave., Buffalo, N. Y.

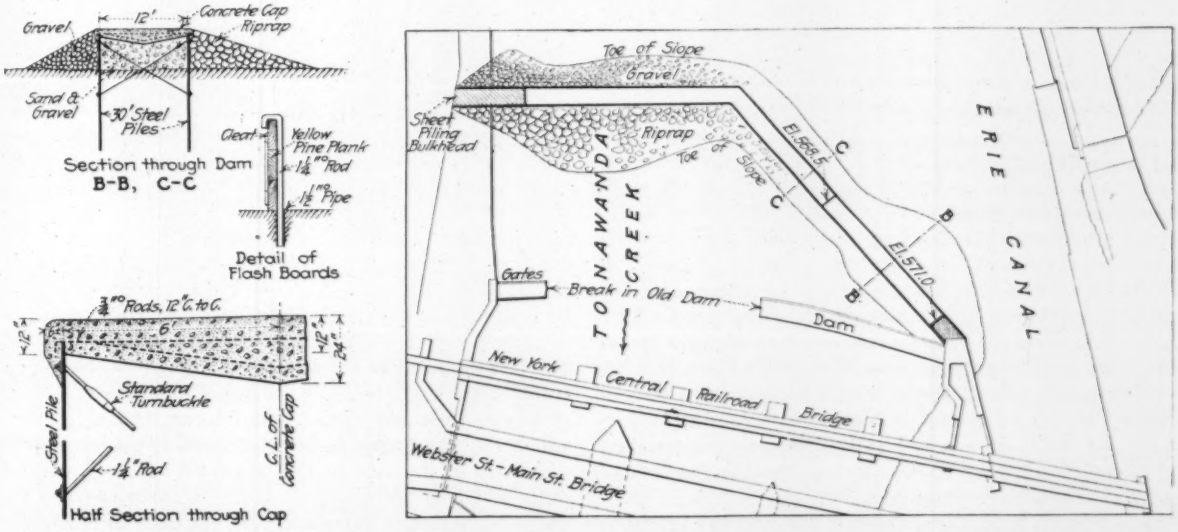


FIG. 1. DETAILS OF DAM ACROSS TONAWANDA CREEK AT TONAWANDA, N. Y.

The greater part of the crest of the dam is built to El. 568.5 ft., a short stretch at the west end being 571.0 ft. or 2.5 ft. higher. The low portion of the dam is arranged for flashboards in 12-ft. lengths, 30 in. high and formed of three yellow-pine planks each 2 in. thick and 10 in. wide, with three 1x4-in. cleats in each section. The flashboards are held in place by 1¼-in. round steel rods, resting in 1½-in. pipes, 12 in. long, previously set in the concrete crest, flush with the top surface. The tops of the rods are bent to hook shape, which when driven down over the top plank made a snug fit, holding the flashboards securely in place.

The lower side of the dam is riprapped with stone and the upper side with gravel to give additional strength. The material at the site is generally clay, some 20 ft. deep, below which is hardpan of varying hardness. The steel sheetpiling was driven by the usual floating pile-driver, the piles driving easily through the clay and relatively harder in the hardpan.

The engineer's estimate for the work was $36,052.81 and the contractor's itemized bid as follows:

Item	Quantity			
1	0.46	M ft. sawed yellow-pine lumber	$60.00 =	$27.60
2	1	M ft. contingent sawed lumber	1.00 =	1.00
3	3,036	cu.yd. gravel filling	1.34 =	4,068.24
4	20,065	sq.ft. steel sheetpiling	1.00 =	20,065.00
5	203	cu.yd. second class concrete	8.00 =	1,624.00
6	6,628	lb. structural steel	.07 =	463.96
7	4,940	lb. metal reinforcement	.05 =	247.00
8	300	cutting steel sheetpiling	.25 =	75.00
9	1,235	cu.yd. third class riprap	3.00 =	3,705.00
		Total		$30,276.80

The contractor for the work was the Henry P. Burgard Co., of Buffalo, N. Y. The piling was driven by Charles A. Dennis, of the same city. The work was in charge of the department of the State Engineer and that of the Superintendent of Public Works, under the immediate direction of B. E. Failing, Resident Engineer, and O. L. Burdett, Assistant Engineer.

Venturi Meter Succeeds in Irrigation

The great increase in areas placed under irrigation and the consequent rise in value of irrigation water have brought an insistent demand for accurate, but still rugged and inexpensive, devices for measuring the quantities applied. The simplicity of the well-known venturi meter long ago led to various proposals to use it in measuring irrigation water, but the expense of the automatic recording devices apparently precluded its immediate use.

The weir and the current meter have been used with few difficulties in determining large flows in main canal systems or important laterals, but the important problem of economically measuring the smaller amounts delivered to the farmer has not been easily solved. It is essential that the successful irrigation meter should be low in first cost and entail little or no operating expense; this is in addition to such obvious requirements as freedom from clogging, few working parts, automatic operation, sustained accuracy, etc. For farmers' ditches the weir has three serious disadvantages in requiring a considerable drop in water surfaces, constant attention to preserve the depth of channel and stream contraction and to prevent backwater at the crest, as well as the lack of a cheap, rugged, accurate recorder.

The venturi naturally overcomes the first two troubles: The drop required is not over 4 in. at full capacity and less at lower velocities; the waterway is perfectly smooth and unobstructed, so that silt and litter are swept along. Only the larger obstructions have to be guarded against—such as should be removed from the canal anyway. The only feature that has required any considerable study has been the recorder. Very satisfactory recorders were already developed for other services where the venturi meter was employed, but the rough conditions prevailing in irrigation work required unusual simplicity and ruggedness. The limitation of cost for the complete meter probably was the greatest obstacle to be overcome.

Studies were early made by F. N. Connet, Chief Engineer of the Builders Iron Foundry, Providence, R. I. (which concern has manufactured the venturi meter since its first appearance on the market). The first of Mr. Connet's devices appeared in 1908, but the development of the irrigation meter was not pushed for several years. The first service installation was made in 1913 for the United States Reclamation Service in Salt River Valley, Arizona. Improvement has continued, and much of the credit for the commercial development of the present meter is due to Howard S. Reed, of Phoenix, Ariz., who was in charge

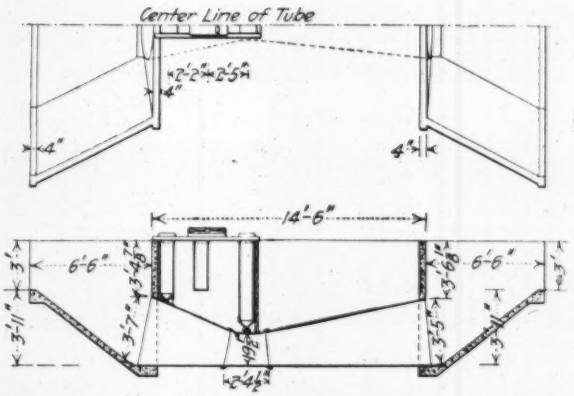


FIG. 1. HALF PLAN AND SECTION; 20-SEC.-FT. VENTURI IRRIGATION METER

of the development of water-measuring devices on this project. At that time the Reclamation Service was anxious to secure a good automatic meter for main laterals, distributaries and farmers' turnouts.

The venturi irrigation meter comprises the usual tube and the recorder. Necessarily the tube follows the usual construction in having two conical ends, of different taper, connected by a short length of straight pipe. The most obvious difference between this tube and those for other services is that the axes of the cones and throat do not form a continuous tangent. Instead, the alignment is by the bottom element of all three, as shown in the accompanying illustrations. This design presents several advantages for installation under the conditions prevailing in irrigation work. The tubes are of cast iron and galvanized plate, concrete, or wood staves—whichever material is most suitable for given conditions and most easily transported.

At the inlet and throat stand large vertical pipes in which the water rises to levels depending on the relative diameters of the tube and on the flow. In each of these wells is a spherical float of such size as to rise and fall freely with changes in water levels, but without much horizontal movement. The vertical travel of these floats is

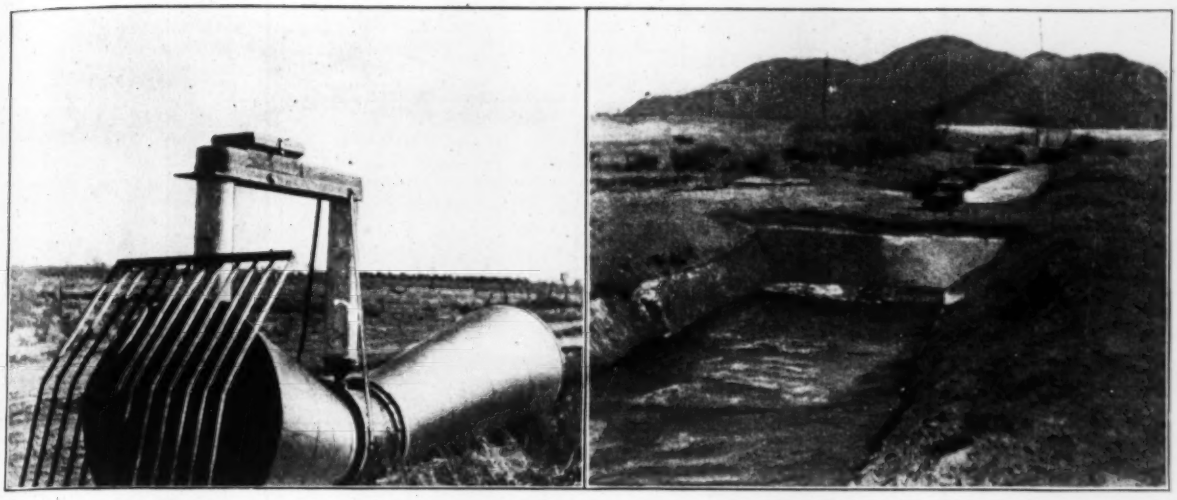


FIG. 2. A 30-SEC.-FT. VENTURI METER BEFORE AND AFTER INSTALLATION
Left—Upstream end. Right—Outlet end. Salt River project

transmitted by counterweighted cables to shafts in the recording mechanism.

The recorder, really the key to the practicability of the field venturi irrigation meter, is made largely of bronze and aluminum parts inside of a heavy cast-iron case, with a hinged cover that can be fastened with a padlock. In the cover is a glazed peep hole by which the rate of flow and part of the chart may be observed. The cables from the floats pass around sheaves and are counterweighted.

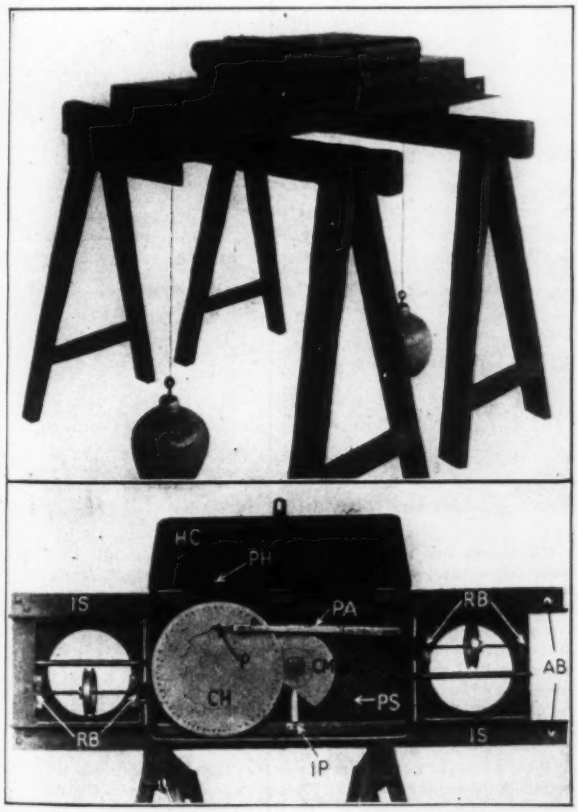


FIG. 3. RECORDER FOR VENTURI IRRIGATION METER
IS, angle-iron supports; AB, anchor-bolt holes; RB, roller bearings of float shafts; HC, hinged cover; PH, glazed peek hole; P, pen; PA, pen arm; CH, chart; CM, cam; IP, fixed index; PS, pen spring

Movements of the sheave shafts are carried to the center of the case by shaft extensions and combined through differential and bevel gears so that the rotation of a cam is made always proportional to the difference of water level in the inlet and throat wells. The outline of this cam is such that its radii are proportional to flow for various inlet-throat head differences. The pen arm bears on the cam edge through a roller and is held against the cam by a long helical spring. The pen-arm shaft bearings are held in a tube that drops into a drilled hole in the cast-iron housing. The cam is graduated, and a fixed index on the case enables checking the pen and chart positions. The float-sheave shafts rest on roller bearings in open brackets, from which they can be easily lifted. A 12-in. circular chart is revolved under the pen arm by clockwork, a new chart being required only once a week. The chart divisions cover 2 hr.; day and night hours are distinguished by shading.

Any size of venturi tube, from 10- to 125-sec.-ft. capacity, can be used with the same recorder. All that is necessary is to substitute longer angle irons and shaft connections from the well boxes to the register case. The recording apparatus is supported free of the float wells; at the upstream end the angles are fastened to the inlet crosswall while the downstream ends are supported on a wooden strut, or iron braces, resting on the throat piece of the meter tube.

The accuracy of a 15-sec.-ft. venturi meter was tested by a board of engineers appointed by the project manager of the Salt River Project at the request of the Salt River Valley Water Users' Association. Twelve separate determinations were made at capacities ranging from 2.96 to 16.86 sec.-ft. in a period of about two months. The venturi figures compared with those from a Price current meter were 2.72% high, and 1.67% below those of a weir; that is, there was a greater discrepancy between the current-meter and weir determinations than between the venturi and either of the others.

There are now important installations of venturi irrigation meters on the Salt River, Sunnyside and Yuma projects of the United States Reclamation Service; in the Imperial Valley by the California Development Co. at Calexico and by the Imperial Water Co. at Imperial; and by the Termescal Water Co. at Corona, Calif.

Traveling Tower Cantilever Crane for Yard Service

An unusual yard crane has recently been put into service by the Cleveland Railways Co. in its new Harvard St. yard. The chief purpose of the machine is to handle sand, coal, broken stone, etc., from and to storage piles. It is a tower crane traveling on a straight track and equipped with a long cantilever jib carrying a traversing hoist from which a grab bucket is suspended.

The general outline drawing herewith shows the structure of the crane quite clearly and gives also the principal dimensions. The tower is carried by two 30-in. rolled-steel double-flanged wheels at each corner. The axle of one wheel of each pair is extended to take a bevel gear driven through shaft and gear connections by a motor just above the portal. The gear shaft nearest the motor carries a brake wheel, with brake shoes pressed against the wheel by springs and released by compressed air when the crane is to be moved.

The top of the tower carries a circular girder 18 ft. in diameter, on which are a rail and a rack circle. The cantilever is supported at four points on the rail by two 24-in. rolled-steel wheels. It is rotated by a pinion on a vertical shaft extending from the rack up to the motor in the machinery house directly above. A manually operated brake controls the rotation. The trolley, a steel frame supported by four 16-in. cast-steel wheels, is designed for handling a 2½-yd. grab bucket, maximum load about 15,000 lb. There are two 20x42-in. drums on the trolley, each driven by a geared motor; one drum handles the closing line and the other the two opening lines of the bucket. The two opening lines are attached to the bucket by an equalizer that holds them 24 in. apart. Equalizers at the ends of the trolley frame provide attachment for two pairs of ropes parallel to the track, leading to a motor-driven winding drum in the machinery house, by which the trolley is moved back and forth along the cantilever.

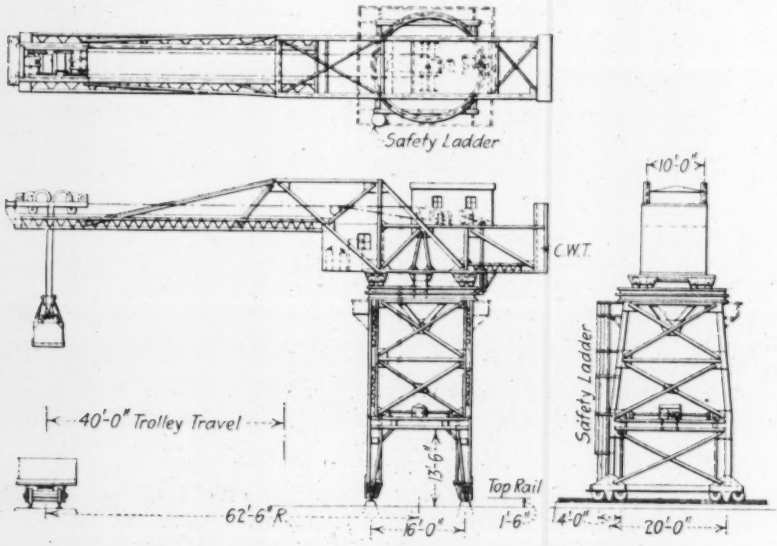


FIG. 1. TRAVELING CANTILEVER YARD CRANE, CLEVELAND RAILWAYS CO.

An operator's cab placed just under the cantilever track and in front of the tower contains all the controllers. This house is an inclosure of asbestos-covered corrugated steel on a steel frame. The floor is of wood. The machinery house, on top of the jib framework, containing the trolley travel and the rotating machinery and an air pump, is a corrugated-iron inclosure on a steel frame with a steel-plate floor. The crane-travel motor, over the portal, is protected by a hinged casing over the motor and brake mechanism. Similar casings are provided for the trolley hoist motors.

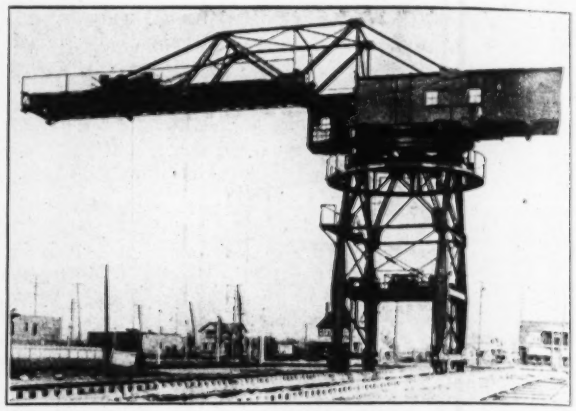


FIG. 2. TRAVELING TOWER CANTILEVER CRANE IN YARD OF CLEVELAND RAILWAYS CO.

The general proportioning of the crane is such as to give a factor of stability of 2, with maximum load in the bucket. The motor equipment includes two 40-hp. motors on the trolley, a 10-hp. motor for the trolley travel, a 40-hp. motor for rotation and a 40-hp. motor for the crane travel, all series wound. The hoist motors have disk magnetic brakes and are governed by magnetic control with dynamic braking; the other motors are handled by drum controllers.

The speeds of the machine are 160 ft. per min. hoist speed at maximum load; trolley travel, 300 ft. per min.; crane travel, 100 to 125 ft. per min.; rotation, 2 r.p.m.

The crane was built by the Variety Iron and Steel Works Co. (Cleveland Railway Supply Co., Cleveland, Sales Agents). The bucket is of Lakewood Engineering Co. make, while the motors are Westinghouse Type K, 550 volts, direct current.

Engineers for Valuation—The valuation of public utilities has given employment to thousands during the past few years and there is no indication that the number of men required will be lessened for several years. This statement was made in a paper by G. L. Wilson, chief engineer of the Twin City Rapid Transit Lines, St. Paul and Minneapolis, read at the recent annual meeting of the Minnesota Surveyors and Engineers Society. The author showed that experience in cost keeping and knowledge of construction costs is necessary if this work is to be done properly. This field, requiring the services of many engineers, should not be neglected. Rather, engineers should post themselves in valuation methods and be prepared to do such work. The proper appraisal of property for purposes of taxation, for revenue charges and to determine values for investment, may be much more important than laying out and supervising the construction of new plants. Further, it may be noted that services of this kind are commanding higher returns than engineering service on projects of construction.

Turbine Pumping Station Below Ground in San Antonio

SYNOPSIS—Artesian-well pumping plant of the San Antonio Water Supply Co., which furnishes the supply of San Antonio, Tex. Greatest interest centers in a steam-turbine pumping station, the floor of which is about 47 ft. below original ground level.

The San Antonio water comes from artesian wells varying in depth from 800 to 1,000 ft. Under normal conditions these wells flow with a head of 12 to 15 ft., but in times of extreme dry weather the head has been reduced. In order that the company might control the supply, the pumps were placed as far below the surface as was practical.

The main pumping station is in the business section of the city, on the banks of the San Antonio River, and derives its supply from 11 wells 8 to 12 in. in diameter. The pumping equipment was installed several years ago and consists of two triple-expansion Allis-Chalmers high-duty pumping engines, one of 25,000,000 and the other of 30,000,000 gal. daily capacity. These maintain a pressure in the mains of from 75 to 90 lb. per sq.in. and pump into a direct system of distribution—without even a standpipe. The high- and low-service lines are connected—but through check valves, automatic valves, and electric valves operated from the high-service station so that the relative load on the stations can be adjusted.

To supplement this supply and furnish service to the high-pressure district of the city, a new pumping station has recently been completed in Brackenridge Park, near some other wells in an outlying section of the city (see Figs. 1 and 2). On account of the high elevation of the ground in this locality, it was necessary to adopt unusual methods in the design of this station so that the pumps could be in a controlling position relative to the hydrostatic level of the wells. This was accomplished by excavating a bowl in the surface of the earth near the river and in this park, the embankment on the river side acting as a protection from floods in the river. The interior of the bowl was terraced. The bottom of the bowl is 2 ft. higher than the normal water level of the river so that generally the bowl drains into the river. At such times as it does not, the storm water is cared for by special pumps for that particular purpose. The main pumps were placed 35 ft. below the bottom of the bowl. The pumping equipment consists of two steam-turbine-driven centrifugal pump units, having a combined capacity of

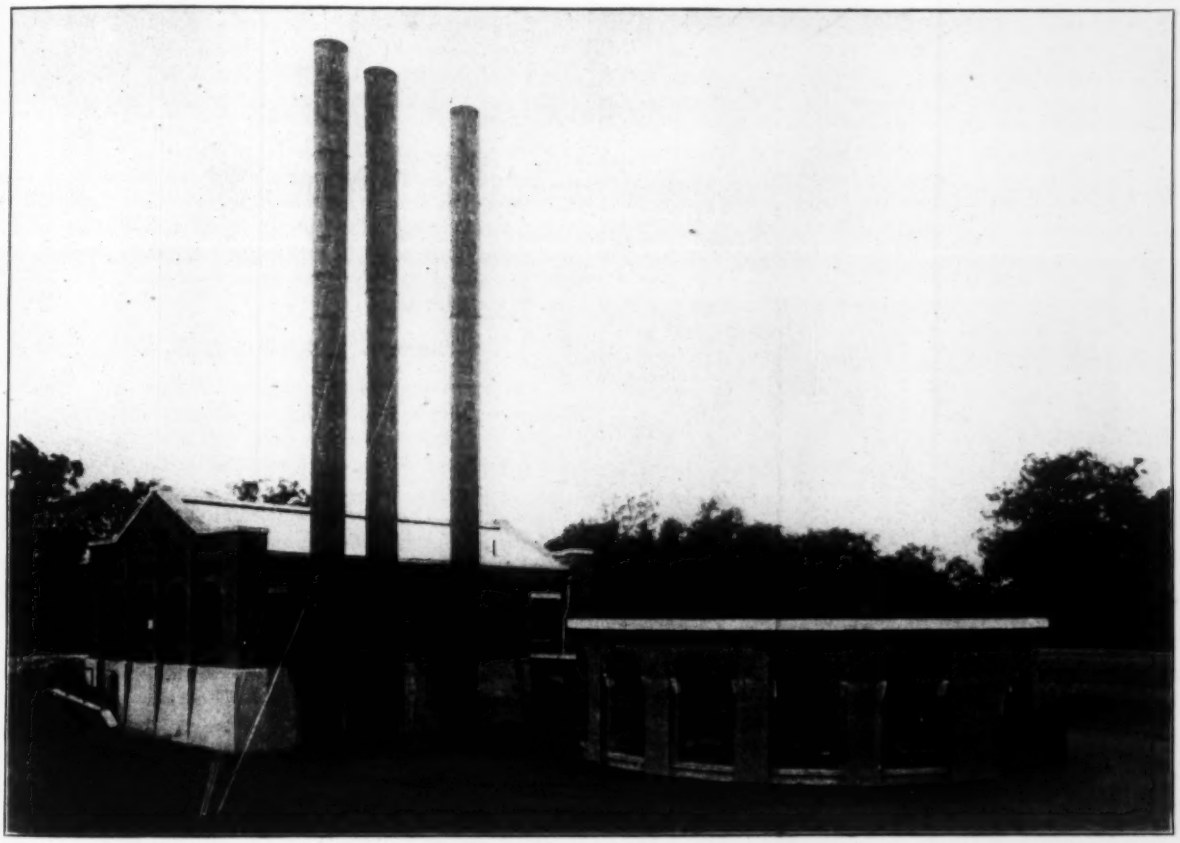


FIG. 1. VIEW OF BRACKENRIDGE PARK PUMPING STATION, SAN ANTONIO WATER-SUPPLY CO.

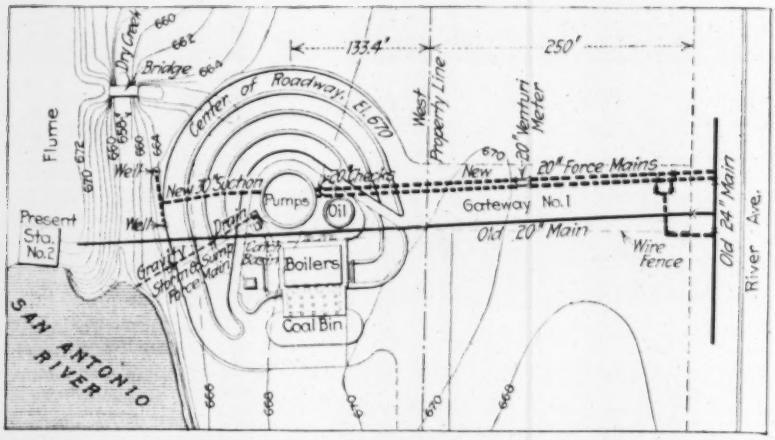


FIG. 2. GENERAL PLAN OF BRACKENRIDGE PARK PUMPING STATION, SAN ANTONIO WATER-SUPPLY CO.

26,000,000 gal. when pumping against 175 ft. head and of 13,000,000 gal. against 273 or 343 ft. head.

The pump chamber was constructed as an open caisson and was sunk in place by excavating the interior. The bottom of the cylinder is a cast-iron shoe with an outside diameter of 54 ft. 4 in., the inside diameter of the reinforced-concrete cylinder being 50 ft. (Fig. 3). The cylinder was built in three sections, each approximately 12 ft. high. The reinforcement consists of steel rods, steel bands, angles and fittings, as shown in Fig. 6. The concrete was mixed 1:2:4.

In the first cylindrical section of the concrete caisson a 40-in. hole was made and filled with a substantial water-tight wood form (see Fig. 7). When the cylinder reached its final position, this form was removed and the 30-in. suction pipe inserted in the tunnel prepared for it. The pipe was then concreted in the tunnel and around the opening in the caisson, so as to give a water-tight fit.

No exceptional difficulties were encountered in sinking the caisson. The upper strata of material were silt and gravel through which the cylinder slipped easily—in fact in some places a little too freely. Below this was a hardpan, so tough as to break the tip off some of the iron shoe. Each section of the cylinder was tied to the one above by a 6-in. steel band, extending 3 in. into each section. Forms were made of wood strips of no greater width than 3 in. and were thoroughly braced so that the interior surface, as shown in Fig. 9, is almost perfect. Care was taken, of course, that the first section was not subjected to any stress before the concrete had thoroughly set. The steel I-beams for carrying the stairs and piping were cast in place in the cylinders as they were sunk.

The roof of the pumping plant is made of 4-in. reinforced concrete on steel I-beams. The lower 3½ in. is 1:2:4 concrete and the upper ½ in. is a 1:1½ mortar placed 30 min. after the lower course. On top of this is tar pitch and gravel. The expansion joints in the roof are filled with tar.

Boiler House, Coal Bins, Etc.

The boiler house is rectangular in plan, with concrete foundation walls and brick superstructure (Fig. 1). The concrete in the foundation walls was mixed 1:3:5; from the foundation to the brickwork the mixture was 1:2:4. The passageway from the boiler room into the pump chamber has 12-in. brick walls and steel beams, carrying a 4-in. reinforced-concrete slab roof covered with tar.

The boiler plant is arranged to be operated with either coal or oil fuel. The coal-bin roof is at ground level, so that the bins are entirely underground and invisible from the outside. The bins are shut off from the boiler room by fireproof rolling steel curtains or doors. The oil tank, which is not shown in Fig. 1, is between the smoke-stacks and the pumphouse. It is constructed of

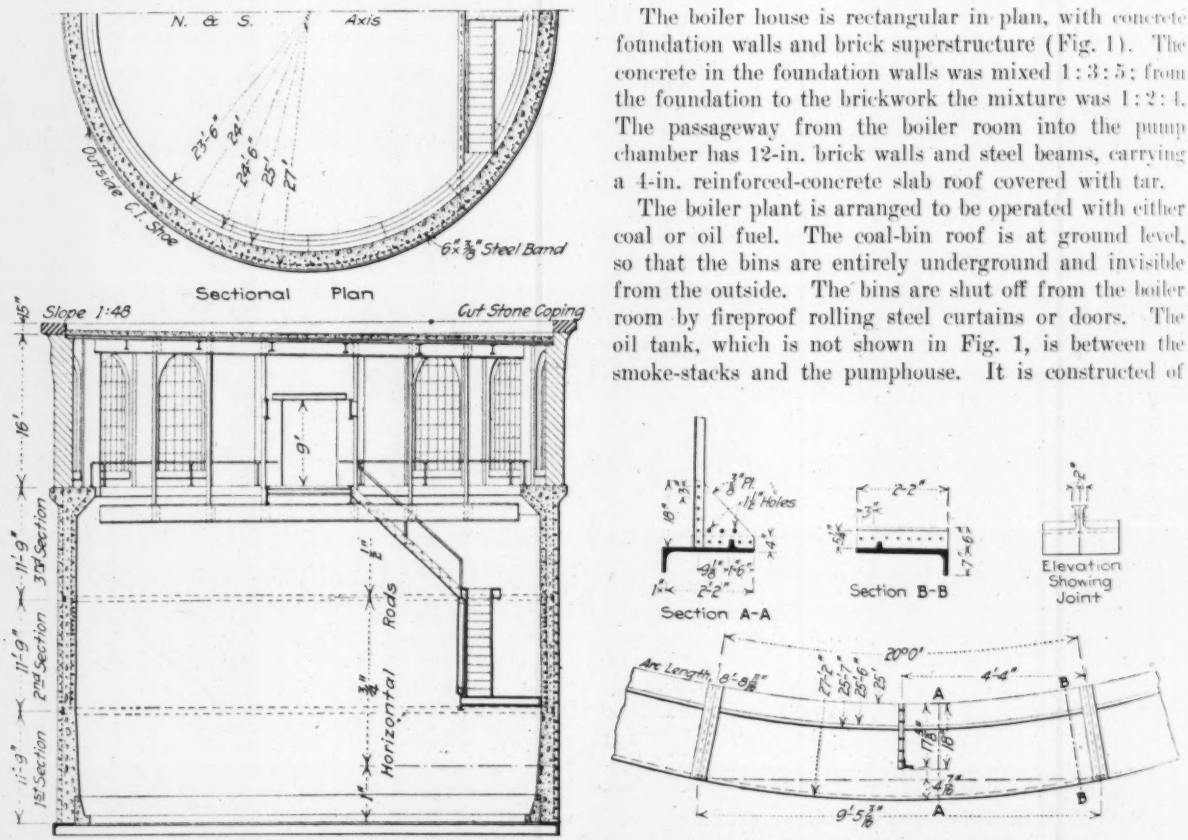
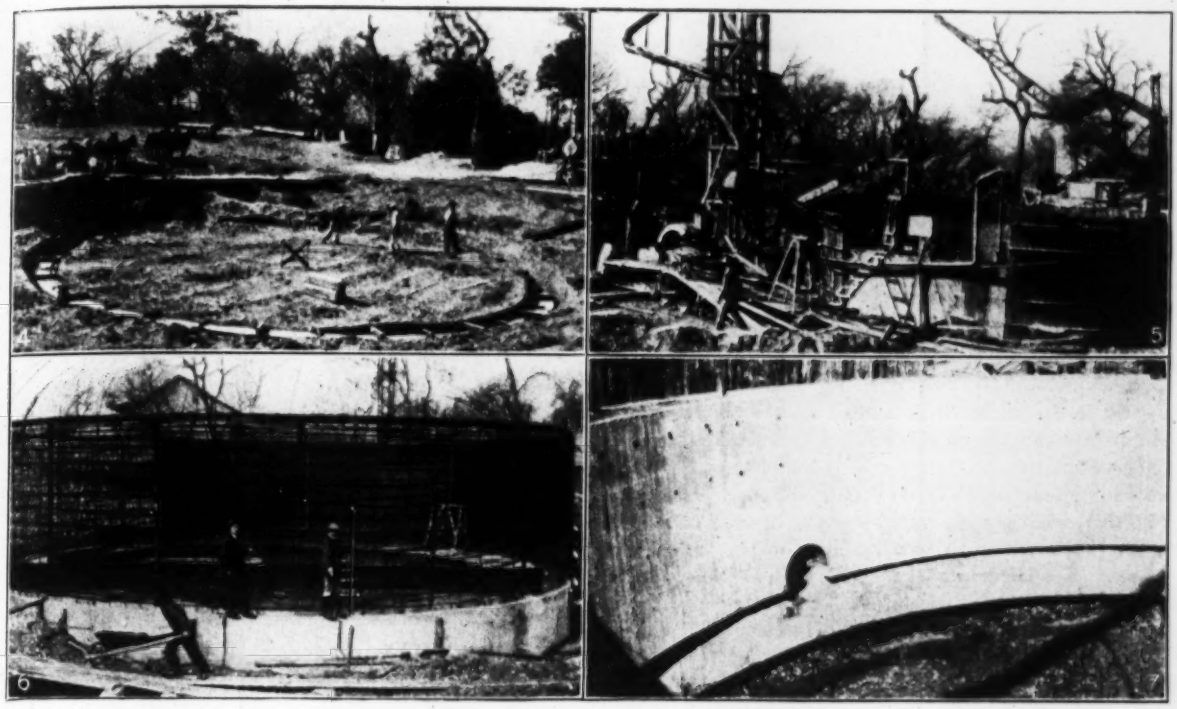


FIG. 3. CROSS-SECTION OF PUMP PIT AND HOUSE; DETAILS OF SHOE FOR CONCRETE CAISSON, BRACKENRIDGE PARK STATION

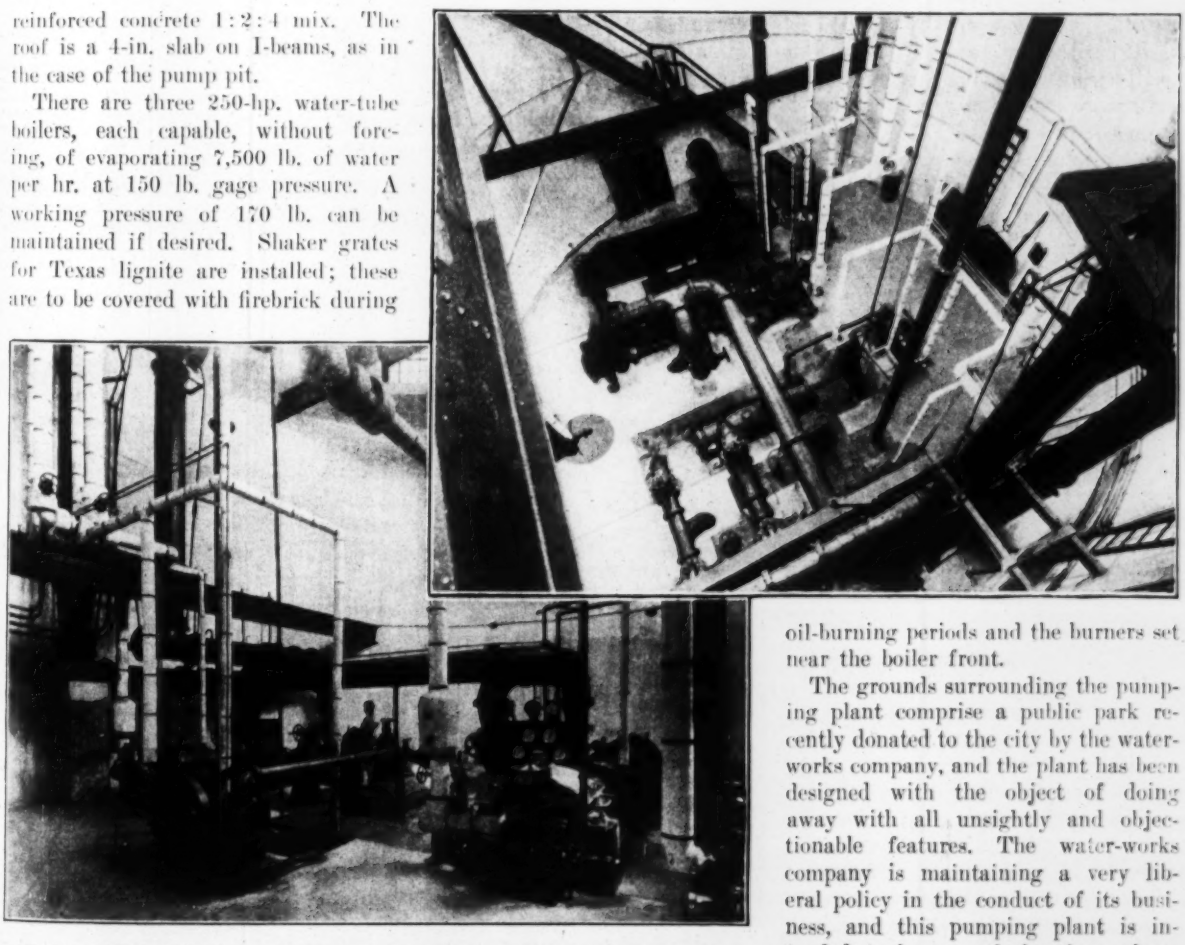


FIGS. 4 TO 7. VIEWS OF THE SINKING OF CONCRETE CAISSON PUMP PIT

4—Cast-iron shoe in position. 5—Placing concrete. 6—Reinforcement in position. 7—Bottom section of caisson, showing opening for suction pipe

reinforced concrete 1:2:4 mix. The roof is a 4-in. slab on I-beams, as in the case of the pump pit.

There are three 250-hp. water-tube boilers, each capable, without forcing, of evaporating 7,500 lb. of water per hr. at 150 lb. gage pressure. A working pressure of 170 lb. can be maintained if desired. Shaker grates for Texas lignite are installed; these are to be covered with firebrick during oil-burning periods and the burners set near the boiler front.



FIGS. 8 AND 9. INTERIOR VIEWS OF BRACKENRIDGE PARK PUMP PIT

The grounds surrounding the pumping plant comprise a public park recently donated to the city by the water-works company, and the plant has been designed with the object of doing away with all unsightly and objectionable features. The water-works company is maintaining a very liberal policy in the conduct of its business, and this pumping plant is intended to be one of the show places

of the park, being open to visitors at all hours. The pump pit, or caisson, is surrounded inside by a high gallery, from which a bird's-eye view, such as Fig. 9, can be had of the whole interior. Drives, flower beds, shade trees and other features are being added to make the plant as attractive as possible.

Pumping Equipment of Station

In the pumping station are two steam-turbine-driven centrifugal units each rated at 6,500,000 gal. normal daily capacity. The pumps are designed for use in parallel on 175-ft. head (each then having a daily rated capacity of 13,000,000 gal.) or in series against heads of 273 or 343 ft. The normal operating head is 273 ft., and the highest pressure is used only for fires. Water is delivered to the pumps with a head of 5 to 50 ft., but the pumps are capable of operating with suction lift up to the usual maximum. Each unit is complete with a water-works-type surface condenser (for minimum vacuum of 28.5 in.), reciprocating pump, moving condensate to feed-water heater, and a crank-and-fly-wheel dry-vacuum pump. The condensers have side water connections to minimize the necessary station depth. The guaranteed duties of the pump units were 112,000,000 ft.-lb. per 1,000 lb. steam (saturated, 150 lb. gage) for 175 ft. head, 107,000,000 for 273 ft. and 112,000,000 for 343 ft.

The station also has in irregular operation two small low-lift turbine-driven pumps. One, having a capacity of 200 gal. per min. against 65-ft. head, is for pumping seepage and circulating water from a station pump pit; the other, having a capacity of 2,000 gal. per min. against 25-ft. head, is for handling storm water. Each of these small turbines runs noncondensing. The entire pumping equipment, including the auxiliaries mentioned, cost about $29,000 in place. The cost of the installation including building and equipment of all kinds totaled about $138,000. In an equivalent triple-expansion unit the pump alone would cost at least $105,000.

The foregoing data were obtained from Robert J. Harding, Vice-President and General Manager of the San Antonio Water Supply Co., who was chief engineer for the design and construction of the plant described.

Reinforced-Concrete Stairway for Hillside Footway

By R. F. Odell*

There has recently been completed at Passaic, N. J., a reinforced-concrete street stairway providing access to the top of a steep hill in Harrison St. and replacing an old wooden structure that had fallen into a bad state of repair through neglect. The hill is very steep, with a slope of about 44%, and attains its full height of 65 ft. in a horizontal distance of 160 ft. Numerous near-by residences required the construction of a permanent footway up the slope.

Details of the structure are shown in Fig. 1. It consists of three-pedestal piers carrying platforms 9 ft. 6 in. wide and 5 ft. long, with offset steps spanning, as slabs, the adjoining platforms. The upper and lower landings are of solid concrete, 5 ft. in width, 10 ft. and 8 ft. in length respectively. A slope of ¼ in. per ft. was allowed in each platform to provide proper drainage.

The stairs are 5 ft. in width throughout, with 10¾-in. treads and 7-in. risers. They were constructed in five spans of 13 ft. 5¼ in., one span of 9 ft. 10¼ in. and one span 4 ft. 5¼ in. in length; the short bottom length was constructed solid to the subfoundation. As shown in Fig. 1, each span consists of a slab 5 ft. in width and 5.83 in. in thickness normal to the bottom, increasing to a thickness of 9.17 in., also normal to bottom, for a width of 7 in. on each side, these projections forming a shallow girder to obtain additional stiffness. In each span the reinforcing is uniform. The longitudinal sys-

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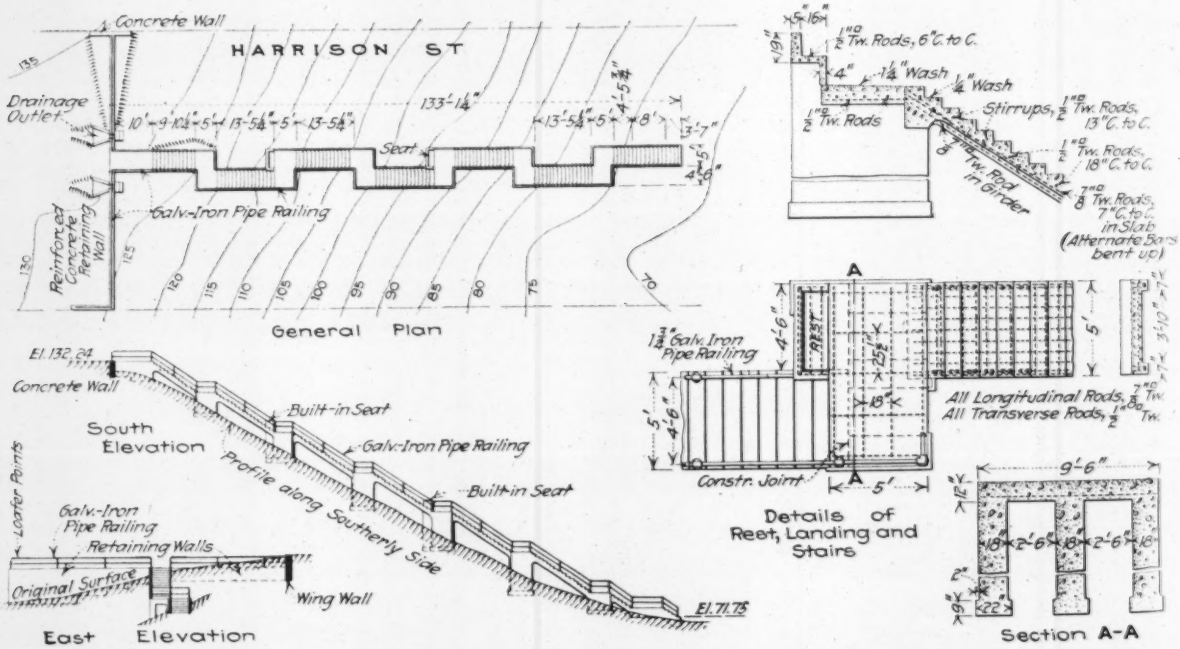

FIG. 1. DETAILS OF STAIRWAY BUILT BY CITY OF PASSAIC, N. J.

FIG. 2. CONCRETE STAIRWAY AT PASSAIC UNDER CONSTRUCTION

tem consists of ⅞-in. square twisted rods spaced 7 in. c. to c. with alternate rods bent up to provide for shear. One ⅞-in. rod was also placed in the bottom of each girder.

Stirrups of ½-in. square twisted rods were placed 13 in. c. to c. in the girders, as shown. Additional ½-in. square twisted rods were placed in the transverse direction, as shown in Fig. 1.

A rather novel feature was the placing of two ½-in. wrought-iron bolts, threaded ends up, in each end of each tread. By this means it is possible to bolt planks to the treads, if required in slippery weather. The treads were float-finished, however, and the use of the planks has been so far avoided. At a slight additional cost, patent nonslip treads could have been installed and would have been an ever present safeguard. The idea was abandoned by the designer because of the necessity of keeping within a small appropriation.

At the fourth and sixth landings concrete seats were constructed, as shown in Fig. 1, to afford rest from the long climb. This was a feature not included in the old structure, and it is much appreciated, especially during the summer months.

In order to afford adequate protection to traffic, concrete wing walls were constructed at the top of the structure. The portion north of the stairway is a plain concrete wall 1 ft. thick and about 3 ft. deep, serving as an anchorage for the guard rail. The conformation of the ground made it necessary to construct the portion south of the entrance of reinforced concrete, retaining an earth-fill 7 ft. in height at its extreme southerly end. Two outlets were provided throughout the wall, one on each side of the upper landing, to provide for a small amount of water draining easterly from the hill crest.

The whole structure, including the wing walls, is surmounted by a galvanized-iron pipe railing 2 in. in diameter. If this detail had been left to the discretion of the engineer, pipe of 3 in. nominal diameter would have been employed. As it is, the small pipe imparts a "spider web" appearance that is certainly out of place with the rest of the structure. The railing on the wing walls was provided with loafer points for its entire length.

Full data relating to the design of the stairway slabs could not be obtained. The writer has investigated the design with the aid of the usual beam formulas and has found f_c = 800 lb. per sq.in. and f_s = 16,000 lb. per sq.in. These values were obtained by assuming the dead-load at 115 lb. per sq.ft. and live-load at 50 lb. per sq.ft. normal to the slab; the combined vertical load totals 188 lb. per sq.ft. No allowance was made for snow or wind loads, the assumption being made that the live-load would be very small at times of heavy snow or high wind.

High elastic-limit steel was used, with concrete proportioned 1 : 2½ : 5. The foundations for the piers were excavated by ordinary day labor and were carried to varying depths, according to the nature of the soil. In several instances it was feasible to place the piers directly on good shale rock; but where no rock was available, no difficulty was encountered in finding suitable soil.

All piers and landings were completed and forms stripped before proceeding with the erection of the stair forms. Room was gained for the stair-slab seats by forming a jog in the landing slabs 1 ft. wide and 5 ft. long, extending down into the piers. The stair slabs were anchored to the piers by means of ½-in. square twisted rods, placed vertically. No direct provision was made for contraction, as it was assumed that the reinforcement would be sufficient for the purpose.

The concrete plant was located at the top of the hill and consisted of a ¼-yd. gasoline-driven mixer, to which the material was delivered by barrows. The concrete was deposited by means of a V-shaped wooden chute, which is shown in Fig. 2.

The entire structure, including the painting of the railing, was erected at a total cost of $1,851.45 and was completed in 50 days by the Gerritsen Construction Co., Lodi, N. J., under the direction of Colin R. Wise, City Engineer, who was also the designer.

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The Unreliability of Shale as a Foundation Material for important structures is remarkably illustrated by the failure of a pier of the Penistone viaduct on the Lancashire & Yorkshire Ry. in England, which occurred on Feb. 2, 1916. A brief account of the accident was published in "Engineering News" of Mar. 9, p. 486. Additional information has now been furnished to us by Sir John Aspinall, general manager of the railway. The viaduct has 29 arches of 30-ft. span each, supported on piers of cut-stone masonry. The viaduct was built in 1849 and during its 67 years of service had never given the slightest indication of weakness at any point until about a fortnight before the accident, when a small crack was noticed in the masonry of the parapet over the pier that afterward failed. Examination of the pier and foundation revealed nothing wrong. The failure occurred very suddenly, only eight minutes after a fast express had passed over the viaduct and when a switching engine was moving slowly across. Excavation of the pier foundation since the accident shows that the footing courses of the pier rested on a greasy shale rock and that the whole pier, notwithstanding its lateral support at the top by the connection of the arches resting upon it to the other piers, slid on the shale foundation. The masonry of the pier and arches was of excellent quality. Excavation has now been carried through the shale to firm rock beneath, and the pier and arches are being rebuilt as they were originally.

Engineering Literature

Los Angeles Aqueduct Report

The plan adopted for distribution of the report on the Los Angeles Aqueduct construction, described in a letter from the president of the Los Angeles Department of Public Service in *Engineering News* of June 8, 1916, is worth the general attention of engineers who are responsible for the preparation and distribution of official reports on important engineering works.

Most public documents issued by states or cities are published for free distribution and are customarily sent to whoever requests them, until the edition is exhausted. When a report is to be issued on an important and monumental piece of engineering work, it is very desirable that it be made available to all engineers who would value it and preserve it. The taxpayers of the city, however, ought not to be asked to bear this expense as will be the case if the volume is sent free to all who apply. Furthermore, free distribution of an important document is sure to divert a large part of the edition to those who send for it from curiosity and who will not permanently preserve it, while on the other hand many engineering reference libraries will find themselves unable to secure it.

Under the plan adopted, the moderate price of $1.95 is placed on the report (less than the cost of manufacture and distribution). As only such an edition is to be printed as is subscribed for in advance, all who desire a copy of the report should lose no time in sending the price mentioned to the Board of Public Service, Los Angeles, Calif.

CORRESPONDENCE

Selling Price of Books

Sir—It is seldom that any attempt is made to have humorous items appear in engineering books, but on occasions amusing features are unintentionally included in some of them. An illustration of this is the habit acquired of late years by many book publishers of inserting in each book a printed slip stating, "This book is supplied to the trade on terms which do not admit of discount." After reading this warning, the interested seeker after information quite naturally examines the volume to find what the price is that cannot be discounted. This is where the publisher has the laugh on the inquisitive engineer, as the price is never given in the book.

The reverse view of this inconsistency is shown by many books in our trade literature which have a selling price printed on the title page, but which are seldom sold and are intended for complimentary distribution. As these are usually very useful and valuable books, the engineer who secures them free can feel that the joke is not at his expense.

Good technical books are worth the price usually charged for them, and it is difficult for the layman to understand why the selling price is not printed on the title page of every book. This would serve as a record for the purchaser and would also be a convenience to anyone who might examine the book and find it of sufficient interest to be a desirable addition to his library.

O. W. CHILDS.

Washington, D. C., June 3, 1916.

An Early Surveyor-Poet

Sir—The accompanying verses on surveying and the notes which follow them I have taken from the genealogical history of the Blake family (with which I am connected) by Samuel Blake, member of the Dorchester Antiquarian and Historical Society:

LINES ON SURVEYING

By James Blake

Upon our Needle we depend,
In the thick woods our course to know;
Then after it the Chain extend,
For we must gain our distance so.

Over the hills, through brushy plains,
And tedious swamps, where is no track,
'Cross Rivers, brooks, we with much pains
Are forced to travel forth and back.

Briars and thorns our flesh do tear,
And stubborn brush our garments rend;
Our Instruments need much repair,
Labour and toil our Spirits spend.

Sometimes with heat we are oppressed,
Then flies and Serpents they annoy us;
Sometimes for cold we have no rest;
And sudden heat and Cold destroy us.

Our fare is mean, our hardships great,
Amidst all which our Charts must keep,
And work come right, our lines run strait,
All plotted be, before we sleep.

When weary steps have brought us home,
And chain and needle have respite,
Scale and dividers in use come,
And fit all for next morning light.

And though we're careful in the same,
As haste and obstacles will yield,
Yet, oftentimes perhaps will blame,
When rough—Wild woods are made a field.

Written May 3, 1730.

There are deposited in the library of the Dorchester Antiquarian and Historical Society many plans of land in Dorchester and the neighboring towns, also other documents, by James Blake, together with one of his dialing instruments, all of great interest to antiquaries.

He was a noted land surveyor and made an actual survey of the whole of the then extensive town of Dorchester. In 1726 the "Annals" say:

This year Majr. Robert Spur, Roger Billing, Capt. Oliver Wiswell, Capt. Thos. Tileston, & Capt. Saml Paul, Committee, & James Blake Junr. Surveyor, began in ye month of May to measure ye Cedar Swamps, &c. This year ye Proprietors, Incorporated into a distinct Body from ye Town, And ye Colony Line Run & Settled by ye Gen. Court.

James Blake was Proprietor's Clerk for the owners of extensive tracts of land in the town of Stoughton. In 1726 the "Annals" say:

> Punkapaog or ye South Precinct with ye Lands Beyond it in ye Township of Dorchester, were sett off a Township by themselves, by ye name of Stoughton, leaving Dorchester but a small Town, being narrow, and but abut 9 or 10 Miles in length.

I think the "Lines," which are perhaps the oldest verses on surveying written in the United States, will be of interest to the engineering profession.

CHARLES E. BEE,
Assoc. M. Am. Soc. C. E.
Gresham, Ore., May 13, 1916.

REVIEWS AND NOTES

Water-Conservation Problems

REVIEWED BY F. H. NEWELL*

CONSERVATION OF WATER BY STORAGE—By George Fillmore Swain, Gordon McKay Professor of Civil Engineering in Harvard University; Past President, American Society of Civil Engineers. [Addresses delivered in the Chester S. Lyman Lecture Series, 1914, before the Senior Class of the Sheffield Scientific School, Yale University.] New Haven, Conn.: Yale University Press. Cloth; 7x10 in.; pp. xvii + 384; 91 illustrations. $3 net.

During the present protracted and somewhat heated discussion of the water-power bills before Congress the book by Professor Swain on "Conservation of Water by Storage" has peculiar interest.

The most striking feature of the book is Professor Swain's somewhat full discussion of conservation in general and his criticism, sometimes direct and at other times implied, of the men who have been prominent in conservation activities. While not mentioning Gifford Pinchot and his associates by name, yet to anyone familiar with the subject it is apparent that Professor Swain is advocating the viewpoint which is radically different from that so ably presented by the National Conservation Association of which Mr. Pinchot is president.

The broad facts of conservation in general, and in particular of the storage of water, are given in an interesting way. Two divisions of the latter topic are treated in separate chapters: First, that of water power which is being developed or may be created at dams built or authorized by the Government on navigable streams; and second, the closely related, but fundamentally different, problem of water power on the public lands, situated in the Western States and still under the control of Congress.

All will agree with Professor Swain that there is urgent need of better and more explicit water laws and will join in his regrets that so much time has been wasted in enacting them. It is to be hoped that this full consideration will not only educate the public but will also arouse a larger appreciation of the necessity of exercising wisdom in the matter of new laws guarding our natural resources for the greatest good of the largest number. Professor Swain urges with reference to water power that "instead of restriction the greatest possible use should be encouraged. That use should not be wasteful; nor is it consistent with sound principles of public and individual economy to have it used for extravagant purposes. But *any use* is better than *no use at all*." His desire to have the water put to immediate use may be interpreted by strict conservationists as a willingness to sacrifice the broad principles to secure an immediate gain. He says:

> To his mind, there is no evil which can arise in the future from the unrestricted private or corporate control which cannot be legally remedied if it should prove dangerous to the community, or which is as serious a loss of the multiple conservation which the development of water power affords. There are many, however, who emphatically dissent from this statement, and who think that no development at all is much better than a development without due regard to the rights of the public—that is to say, to what they conceive to be the rights of the public.

The author points out that the impression is erroneous that "water power can be developed at very little cost and with very little risk." Continuing, he says:

> The risks attending this investment are serious. The history of water-power enterprises is not by any means a history of unbroken successful efforts. It is strewn with wrecks, and there is no industrial field in which sound engineering preliminary judgment, as well as careful construction and economical financing, would seem to be more necessary.

Farther on, it is stated that "the conservation movement in the past, particularly as regards water power, has been too much dominated by the idea of enforcing the arbitrary powers of the Federal and State governments." The author is convinced that the Federal Government has no legal right to impose any charge for water power at private water-power dams on navigable streams, but shows that the contrary opinion has been supported by ex-Presidents Roosevelt and Taft, by Henry L. Stimson when Secretary of War and by Walter L. Fisher when Secretary of the Interior. He asserts that "the conservation movement, originating in a wise demand for the economical use of our natural (not national) resources, has too much deteriorated into a demand that those resources be retained by national Government and not permitted to be developed by private capital, except under restricted burdens." He also dwells upon the fact that "it is very important to avoid the attitude of mind taken by so many in these days, which assumes that average business morality is less than average public morality." He adds: "Government bureaus and officials in a democracy may be guilty of just as flagrant abuse of justice as kings or individuals."

Passing from the discussion of the political aspect of water conservation, Professor Swain devotes considerable space to a similarly much debated question—namely, the relation between forests and stream flow. After presenting the results of various investigations he cautions the reader against "extreme views, in either direction, with regard to the effect of forests," for:

> In this, as in every other subject that engages the human mind, men tend to go to extremes. Thus we find some who maintain that forests exert no beneficial influence upon stream flow, and are even positively injurious; while on the other hand some seem to believe that the preservation and extension of forests would absolutely regulate the flow of streams and would do away with floods entirely. Either view is manifestly wrong. The truth lies somewhere between.

The book closes with a chapter on floods. The appendix quotes various reports, presidential vetoes and other documents relating to attempted water-power legislation. There is also an excellent list of references.

The book as a whole is of interest not only to engineers, but also to citizens in general. While many will dissent from the conclusions on nonengineering topics,

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yet all will agree on the value of the presentation and of the convenient access afforded to the literature on this important subject.

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For Engineers and Architects

REVIEWED BY CLYDE T. MORRIS*

THE STRENGTH OF MATERIALS: A Textbook for Engineers and Architects—By Ewart S. Andrews, Lecturer in the Engineering Department of the Goldsmiths' College, New Cross, and at the Westminster Technical Institute. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. x + 604; 264 illustrations. $4 net.

The subtitle, "A Textbook for Engineers and Architects," has evidently been kept in mind throughout the preparation of this book. All the subjects treated are handled from an engineering viewpoint and their practical uses emphasized. The following statement from the preface shows the author's aim:

> Nearly all engineering formulas are only approximately correct; . . . We cannot condemn too strongly the blind application to a particular problem of formulas which were never intended to be so applied; the unfortunate distrust which practical engineers so often have to "theory" is to some extent brought about by the fact that the theories that they see employed are often inapplicable.

There are many references in the text to the practical aspects of design, and many numerical examples are worked out showing the practical application of the formulas and principles developed.

The more abstruse and less frequently used parts of the subject, such as are often omitted or put in appendices, are placed in the body of the text in their proper order, but they are "marked with an asterisk and may be omitted on the first reading." This makes the book more valuable as a reference text and still suitable for the usual undergraduate engineering course. The subject is presented in 20 chapters that cover the usual topics as well as a few less frequently met with.

Chapter I, "Strain, Stress and Elasticity," in addition to the usual relationships of simple stresses gives the principal stresses and the ellipse of stress, marked for omission on the first reading. Chapter II, "Behavior of Materials Under Test," is good, and Chapter III, "Repetition of Stresses," contains an exceptionally well-written discussion of working stresses and factors of safety. The methods given of caring for impact in live-load stresses do not include the American Railway Engineering Association formula and are generally more cumbersome and less accurate.

Chapter IV, "Riveted Joints and Thin Pipes," seems a rather odd combination. The part on riveting gives little attention to the theory of riveting, but mainly deals with various practical rules that are not in use in America.

Chapter V, "Bending Moments and Shears on Beams," is good. Chapter VI, "Geometrical Properties of Sections," gives the usual demonstrations for centroid, moment of inertia, radius of gyration and also graphical methods of finding the same which are very good.

Chapters VII, "Stresses in Beams," VIII, "Reinforced-Concrete Beams and Oblique Loading," and IX, "Deflection of Beams," give the usual treatment. The graphical method for deflections is well given, but the mathematical demonstration is not complete in that the author assumes $\frac{M}{EI} = \frac{1}{R} = \frac{d^2y}{dx^2}$, without showing the terms neglected.

Chapter X, "Columns, Stanchions and Struts," does not agree with standard American practice and does not give the underlying theories upon which many of the formulas used are based, nor does it give any test data to show the accuracy of them. Euler's and Rankine's column formulas are recommended for practical use, and the straight-line formula is referred to as being "used principally in America and giving very good approximations for rough working." Euler's formula is recommended also for reinforced-concrete columns.

Chapter XI, "Torsion," again does not give the underlying theory as well as might be expected. Three different formulas are given for combined torsion and bending, but there is no demonstration of their theory.

Chapters XII, XIII and XIV, on "Springs and Testing of Materials," are fair. The description of extensometers might have included the Berry strain gage, which has been found invaluable in this kind of work. Chapters XV, "Fixed and Continuous Beams," and XVI, "Distribution of Shear in Beams," are good. Chapter XVII, on "Flat Plates and Slabs," is very good. The girderless floor is not considered. Chapter XVIII treats of pipes, and Chapter XIX of curved beams, in which is given a good treatment of the stresses in chain links. Arches and hooks are not considered. Chapter XX, on "Rotating Drums, Disks and Shafts," is very good.

At the end are given a set of problems for each chapter, tables of the properties of British standard sections and a table of logarithms and antilogarithms.

References in the text to other authors are usually made by name only, omitting reference to the publication in which the particular theory may be found. This fault could be easily corrected.

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Folwell's Sewerage Revised

SEWERAGE: The Designing, Construction and Maintenance of Sewerage Systems—By A. Prescott Folwell, M. Am. Soc. C. E., Past-President, American Society of Municipal Improvements; Editor of "Municipal Journal and Engineer." Seventh edition, revised and enlarged. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. x + 540; 46 illustrations. $3 net.

In the present edition of his well-known book on "Sewerage" the author has confined his attempts at revision to the portion devoted to specifications, where he has substituted the specifications not long ago adopted by the American Society of Municipal Improvements, and to the section on sewage disposal. In the latter he has given chief attention to advances in screening, to changes in tank treatment, and he has added a couple of pages or so on activated sludge. Besides giving a descriptive tabulated list of about 900 sewage-treatment works and adding instructions for testing sewage effluent, the portion of the section on sewage treatment, devoted to what the author terms "more refined purification," has been reduced in length.

By the use of smaller type for the specifications than was used in the earlier edition the pagination of the volume and its contents up to that point, except for the new specifications, remain unchanged until page 400, where sewage treatment begins. The net changes under the heading "Sewage Treatment" increase the size of this section of the book as a whole by about 35 pages.

In the sixth edition, published in 1910, the principal changes, as compared with the preceding edition, appear to have been in the sections dealing with the use of

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concrete and with sewage treatment. It would therefore appear that, except for matter on the increasing use of concrete, the new specifications and two successive revisions of the section on sewage treatment, the volume is not materially changed from the earlier edition of some 15 years ago. The author can hardly be blamed for not going into extensive changes in a one-volume work on sewerage and sewage disposal in view of the two volumes by Professor Ogden, published since the earlier editions of Folwell, and particularly since the appearance of the three-volume work entitled "American Sewerage Practice," by Metcalf and Eddy. It is hard and discouraging work at best to keep any engineering book up to date. Mr. Folwell is to be congratulated in finding the demand for his single-volume work continue until now 19,000 copies have been issued with the present printing of the seventh edition.

Weighed and Found Wanting

SCIENTIFIC MANAGEMENT AND LABOR — By Robert Franklin Hoxie, Associate Professor of Political Economy, University of Chicago; Special Investigator of Scientific Management for the United States Commission on Industrial Relations. New York: D. Appleton & Co. Cloth; 5x8 in.; pp. x + 302. $1.50 net.

Much has been heard of the opposition of organized labor and of laborers generally to scientific management. After a scientifically conducted study of the subject the author of this volume weighs the evidence gathered with much care and joins with his two "experts," one representing each side, in declaring that the scales tip against scientific management as now conducted in that it does not afford "any adequate protection" to the "standards of living" set by labor.

The general scheme of the investigation, which was made for the United States Commission on Industrial Relations, was as follows: Statements of the claims of the two sides were formulated by the author and submitted to representatives of each side, those representing scientific management being Mr. Taylor, Mr. Gantt and Mr. Emerson, for revision and approval. Shops for investigation were designated by the three exponents of scientific management already named. Robert G. Valentine, Industrial Counselor of Boston, was chosen to represent the "employing management" and John T. Frey, of Cincinnati, Editor of the *International Molder's Journal*, on behalf of labor. Some 35 shops and concerns were visited, and in addition about 150 men on both sides of the case were interviewed. An extended questionnaire was also used.

The main part of the body of the book consists of the author's "Critical Examination" of the testimony gathered from the various sources indicated. It is interesting to note that the author found much diversity as to the theory and still more as to the practice of scientific management. One gathers from his pages that in his opinion most of those who set themselves up as leaders in the field are hardly worthy of the title and that the greater number of the subordinates are incapable, even as regards service to the true interests of their employers, while for the most part they utterly lack in knowledge of the human side of the problems with which they are dealing. The weaknesses of the relations of labor to scientific management the author hardly seems to take so much trouble to present. He doubtless intends to be absolutely fair to both sides; but if he has a bias, it appears to be against scientific management and in favor of labor.

The larger part of the book is taken up with appendices stating the attitude of scientific management toward labor and the claims of labor against scientific management, together with the lengthy questionnaire used in the inquiry.

The body of the book can scarcely fail to appeal to anyone who has much interest in either side of the question at issue, and the various appendices will be almost equally interesting to those who have a special interest in the subject.

Least Squares Explained

REVIEWED BY CALEB MILLS SAVILLE*

THEORY OF ERRORS AND LEAST SQUARES: A Textbook for College Students and Researchers—By LeRoy D. Weld, Professor of Physics in Coe College. New York: Macmillan Company. Cloth; 5x7 in.; pp. xii + 190; 11 illustrations. $1.25 net.

The subject of least squares is often so severely abridged as to lessen greatly the use of a very valuable tool, but in the book under review Professor Weld has admirably avoided this tendency. The author's desire, as stated in his preface, to produce at the same time a textbook for undergraduates and a reference for research workers seems rather too ambitious of consummation. The book is, however, excellently adapted for undergraduate use and is of especial value to those who are dependent on self-help to acquire sufficient facility in applying the principles of least squares to ordinary problems.

The eight chapters into which the text is divided follow each other in logical sequence and treat of their subjects in a clear and concise manner. The text begins with an elementary discussion of "Measurement" and passes through the general subjects of "Errors," "Probabilities," "The Principle of Least Squares," "Adjustments of Observations," Empirical Formulas" and "Weighted Observations," concluding with a chapter on "Precision and Probable Error." An appendix is devoted to advanced mathematical discussion of the principles used in the body of the work. This arrangement is very attractive in that the working formulas appearing in the body of the text may be used intelligently without tiring or befogging the mind, as is often the case with abstruse mathematical gymnastics.

As a whole the text has much of the charm and easy-reading quality that sustain interest in the mathematical books of Prof. John Perry, and it may well find a very useful place in the work-a-day library of a busy engineer as well as be a most instructive guide to the undergraduate student.

Farm Drawing and Structures

AGRICULTURAL DRAWING AND THE DESIGN OF FARM STRUCTURES—By Thomas E. French, Professor of Engineering Drawing, and Frederick W. Ives, Assistant Professor of Agricultural Engineering, in the Ohio State University. New York: McGraw-Hill Book Co. Cloth; 8x11 in.; pp. viii + 130; 182 illustrations. $1.25 net.

Being designed "primarily for students in agriculture and agricultural engineering," this book first takes up the general subjects of drafting and of working drawings. A long chapter dealing with a great variety of farm structures follows. Next come maps and topographical

*Chief Engineer, Hartford Water Commission, Hartford, Conn.

drawing, pictorial drawing, a variety of construction data and a brief bibliography. The subjects selected are practical, many of them having been chosen from executed designs by the authors.

Theory of Dam Design

REVIEWED BY F. TEICHMAN*

DAMS AND WEIRS: An Analytical and Practical Treatise on Gravity Dams and Weirs, Arch and Buttress Dams, Submerged Weirs, and Barrages—By W. G. Bligh, M. Inst. C. E., Inspecting Engineer of Irrigation Works, Department of Interior, Canada. Chicago: American Technical Society. Cloth; 6x9 in.; pp. 206; 122 illustrations. $1.50.

The author thus summarizes his own idea of the advantages of the method he has pursued in presenting the theory of dam design:

> For purposes of instruction in the principles of design no medium is so good as the exhibition of plans of actual works combined with a critical view of their excellencies or defects. The former is obtainable from record plans in many technical works, but the latter is almost entirely wanting.

The book is largely made up of material from chapters II, III and VI of the author's previous work, "The Practical Design of Irrigation Structures," but this material has been revised and amplified and the treatment brought down to date by the inclusion of many designs representative of the most recent practice. In its present form it presents a distinctly valuable, though in parts elementary, work on the mathematical procedure involved in the design of the various classes of masonry dams.

The volume opens with a complete exposition of the various analytical and graphical processes by which a gravity-dam section may be analyzed, the lines of pressure drawn and the maximum pressures determined, including the complete working out of the design of a section of 270-ft. height with a limiting unit pressure of 18 tons. Several of the more notable gravity dams are then analyzed more or less completely, and brief comment is made on their distinctive features. A discussion of the effect of hydrostatic uplift, due to pervious foundation, follows, but the only remedy suggested is the use of a rear apron, either entirely artificial or in part of silt deposited from the reservoir. No mention is made of the method of foundation grouting under pressure, and there is but a passing reference to the possibility of hydrostatic pressure occurring within the masonry body of a dam. The use of a formula for relation of maximum and mean unit stress, in which it is "assumed that any tension at the heel can be cared for by the adhesion of the cementing material or of reinforcement anchored down," and the failure to state clearly that the primary reason for the middle-third requirement is to eliminate the possibility of tension occurring at the heel, while of no moment to the experienced designer, might mislead the uninformed student.

The theory of arched dams is covered by the submission of two formulas—one for average and one for maximum unit stress due to arch action—and the statement that "experience has conclusively proved that if the profile be designed on the supposition that the whole is an elastic arch, this conflict of stresses near the base can be neglected by the practical man." Various existing single- and multiple-arch dams are then analyzed, a design for a differential buttress arch weir is worked out, and several typical flat-deck buttress dams (Ambursen type) are analyzed and criticized.

The next section of the book is devoted to the discussion of submerged weirs founded on sand. These are treated along the lines of two papers on that subject by the author, which were published in *Engineering News* of Dec. 29, 1910, and Apr. 13, 1911, but the present discussion treats the subject at greater length and includes discussions of a large number of examples.

Scouring sluices, barrages and regulating gates are treated in the concluding portion of the work. Some mention should have been made here of the roller dam, as developed under patents by a German firm, of which there have been a number of examples installed both in the United States and in Europe. These roller dams combine the advantages of water-tightness, ease of operation and long unobstructed openings and are entitled to consideration where these requirements are to be met. If this section of the book could be expanded to include examples of actual installations of the different types of gates developed for use in river control in lock and dam work, and the various automatic spillway crest gates, it would form a chapter of considerable interest.

To the designing engineer who desires a compendium of the results of modern theory and practice in this branch of engineering this work should prove of considerable value. The analyses are detailed and complete, the illustrative designs are well selected, and the critical comments of the author not only lend interest and variety to the discussion, but, based as they are on an intimate and varied acquaintance with this class of construction in India and Egypt as well as in America, are illuminative and suggestive. The "inexperienced reader" should be warned, however, that there is something more to the design of a gravity dam, for example, than the drawing of a right-angled triangle with the hypothenuse on a 2:3 batter; and this something more is a matter not only of drawing the line of pressures as per detailed instructions and making correct numerical substitutions in stated formulas, but it demands a knowledge of the underlying principles of graphics and of the derivation of the formulas from the fundamentals. Anything short of that, however skillful detailing it may be, is not engineering design. It is of course entirely outside the scope of the present work to enter into this field, but the very fullness of the treatment of the methods of analysis may perhaps cause the fact to be overlooked that this knowledge of the fundamentals is essential.

Plumbing Drawn and Described

MODERN PLUMBING ILLUSTRATED: A Comprehensive and Thoroughly Practical Work on the Modern and Most Approved Methods of Plumbing Construction—By R. M. Starbuck, author of "Questions and Answers on the Practice and Theory of Sanitary Plumbings." Third edition, revised and enlarged. New York: Norman W. Henley Publishing Co. Cloth; 8x11 in.; pp. 407; fully illustrated by 58 detailed plates made expressly by the author for this work. $4.

Little change seems to have been made in this edition except in minor details. The general scheme of the book is to present one after another element or a combination of elements of plumbing on plates and to accompany each plate with brief text consisting of explanations, warnings and directions. Toward the end the text expands, and various phases of water-supply and

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sewage disposal are presented. The volume closes with "Suggestions for Estimating Plumbing Construction." The plates are clearly presented, but many of the drawings they show might have been reduced to occupy one-fourth the space and printed in the text, thus saving $13\frac{1}{4}$ pages per plate. The type and the margins are also unnecessarily large. If the book were reduced to something like half in bulk and nearly, if not quite that, in price, its convenience and field of usefulness would be increased.

Steam-Boiler Design

REVIEWED BY WILLIAM H. BOEHM*

THE DESIGN OF STEAM BOILERS AND PRESSURE VESSELS—By George B. Haven, Professor of Machine Design, and George W. Swett, Assistant Professor of Machine Design, Massachusetts Institute of Technology. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. vii + 416; 197 illustrations. $2.50 net.

The authors have produced a book on the design of steam boilers and other pressure vessels that is considerably in advance of earlier works on the subject. Their aim is to harmonize rational theory with conservative practice, and they believe that the problems encountered possess particular advantages to students as a basis for the proper study of machine design. Wherever it was possible to do so, the formulas and rules given were obtained by rational rather than by empirical methods.

In the opening chapter the authors state that there is in existence upward of 14,000,000 hp. of boilers used in manufacturing operations in the United States alone. Where a few years ago a 100-hp. boiler was considered a large unit and 125 lb. per sq.in. was considered a high pressure, today 500-hp. units carrying 250 lb. per sq.in. are commonly encountered. The authors are of the opinion that 200 hp. or 78 in. in diameter is about as large a unit as should be adopted if the horizontal tubular type is selected. When vertical boilers are used, 400-hp. units are often employed; and when water-tube boilers are chosen, units of 500 or 700 hp. are common.

Other topics considered in the first chapter are the proper combustion of fuel, the grates, furnace settings, and the materials used in boiler construction. Standard specifications for such materials are given. There is also a digest of the Massachusetts rules for the construction of boilers, which, together with other information, should prove of great value to the designer.

The second chapter presents valuable information on the method of determining the stresses in the various parts of the boiler. The next chapter contains a complete discussion of riveted joints, together with detailed information and numerous tables showing how to determine the net efficiency of the various joints encountered in practice.

The proper proportion of heating surface to grate surface, the proper size of tubes, etc., are discussed in the fourth chapter, which also contains interesting details of construction and valuable information on the staying of flat and curved surfaces. Boiler mountings are profusely illustrated and discussed at length.

Complete specifications, with calculations in detail, are given for horizontal tubular, Scotch marine, vertical and the locomotive type of boilers, there being a chapter for each type. The ninth chapter is devoted to the design of steel tanks.

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The work should not only prove to be a valuable textbook for engineering colleges, but should also be a helpful guide for draftsmen, boiler-shop foremen, inspectors and others interested in the proper design and construction of steam boilers and other pressure vessels. The authors are to be thanked by the entire engineering profession for giving us so much help in such concise form.

Two Books on Welding

AUTOGENOUS WELDING AND CUTTING — By Theodore Kautny. Translated by the Author and James F. Whiteford, M. Am. Soc. M. E. New York: McGraw-Hill Book Co. Cloth; 5x8 in.; pp. xiv + 157; 130 illustrations. $1 net.

OXYACETYLENE WELDING AND CUTTING: Electric, Forge and Thermit Welding, Together with Related Methods and Materials Used in Metal Working and the Oxygen Process for Removal of Carbon—By Harold P. Manly, Chief Engineer, American Bureau of Engineering. Chicago: Frederick J. Drake & Co. Cloth, leather, 4x7 in.; pp. 215; 56 illustrations. Cloth, $1; leather, $1.50.

The growing importance of high-temperature methods of welding and cutting metals is illustrated anew by the recent appearance of two books on the subject.

Mr. Whiteford has given an interesting arrangement of European practice in oxyacetylene welding and cutting of metals, which should interest Americans having such work to do. The sections on Continental apparatus will be of less importance to such readers.

After a brief description of the several autogenous welding flames available, the text settles down to the oxyacetylene process, the one of greatest commercial development. Acetylene and oxygen generation precedes a few brief remarks on fittings and more extended descriptions of welding and cutting torches. The rest of the book (two-thirds) is devoted to welding technique—repairs of cast iron and steel pieces; fabrication of sheet-iron articles, boilers and miscellaneous vessels, small pipes and large conduits; special work on copper, aluminum, nickel, etc.

Mr. Manly's book is another addition of the publishers to a long list of works written for the mechanic, but of such merit and service as to be worthy of a place in the library of many technically trained men. The most of the space is devoted to oxyacetylene apparatus and work, though hand and electric welding and soldering are not perfunctorily passed over. The sections on brazing and thermit welding are too abbreviated to serve for more than casual reference.

The book opens with a short discussion of the methods of producing common metals and alloys, their physical properties and working into commercial shapes. The generation and storage of oxygen and acetylene gases are described at length. Prior to taking up technique of oxyacetylene work, common valves and torches are described. The welding practice as outlined covers advance preparation of the work, torch manipulation, gas regulation, etc.

Pan-American Road Congress

PROCEEDINGS OF THE PAN-AMERICAN ROAD CONGRESS, Held at Oakland, Calif., Sept. 13-17, 1915—New York City (150 Nassau St.): Executive Committee, Pan-American Road Congress. Paper; 6x9 in.; pp. 416. $2.

This bulky volume contains the papers and discussions that were presented at the Road Congress held at Oakland, Calif., Sept. 13-17, 1915, under the joint auspices of the American Road Builders Association and the American Highway Association. Although the attendance at the congress was rather disappointing, the published

volume of "Proceedings" indicates that the meeting was successful in eliciting a large number of papers and extended discussion upon them. While a great deal of the matter in the volume is of only passing interest, highway engineers will probably find some of the papers useful.

Oil Fuel in the Industries

INDUSTRIAL USES OF FUEL OIL—By F. B. Dunn. San Francisco, Calif.: Technical Publishing Co. Cloth; 5x8 in.; pp. 235; 108 illustrations. $3.

Mr. Dunn has gathered in this little volume the most complete collection of descriptions and data of oil-burning equipment yet seen. There are a minimum of general statement and a maximum of specific details and figures. There is an occasional point where the text could have been improved (for instance, where it is stated inadvertently that the density of the air increases with increasing altitude), but all such shortcomings disappear in view of the merits of the work. The author has given great prominence to available commercial apparatus, but without evident partiality as far as he goes; the inclusion of much such matter is essential to a book of this sort, no matter how undesirable in a treatise of thermo-dynamics. The author might profitably have gone farther. The variety of sources for much of the author's matter has led to a lack of uniform style and attractiveness in the illustrations. That does not impair the real usefulness of the book, of course, but it gives it a certain typographical handicap in these days of more attention to the artistic appearance of technical publications.

The author starts out with some comparisons between oil and solid fuels and many data on the physical properties of various oils. Storage and pumping systems are briefly described and then boiler-furnace arrangements found suitable. Not much is said in this last part about burners, heaters, etc.; these are grouped in a following chapter. Kilns, and furnaces for clay, lime, cement and glass works are described as they have been run on oil. There is here much information on the technology of these industries, particularly as it affects oil burning; comparative data on operation are included. Metallurgical work (copper and iron smelting and steel making) are similarly included. There are chapters on oil-burning locomotives and steamers. Small apparatus for domestic household service is taken up with the same definiteness.

Our Great Irrigation Works

IRRIGATION AND SETTLEMENT IN AMERICA—By A. D. Lewis, Circle Engineer, Irrigation Department, Union of South Africa; late of the Public Works Department of Punjab, India. Pretoria, South Africa: Government Printing and Stationery Office. Cloth; 8x11 in.; pp. 258; illustrated. 10/6, post free.

How 17 of the leading irrigation works in the United States impressed an engineer from South Africa and what points regarding them he saw fit to record for the benefit of engineers and government authorities on another continent can scarcely fail to arouse the curiosity of anyone in the United States who is interested in irrigation. In addition, the volume before us has much intrinsic merit because it sets forth in concise and readable terms the leading features of a number of the irrigation projects of the United States Reclamation Service, several Carey Act projects, some California irrigation-district projects and the very interesting Imperial Valley scheme in Southern California.

Besides outlining the irrigation features of the various works, the author pays considerable attention to conditions affecting settlers on the projects, including accounts of some crop experiments. At the close of the volume a brief "summary of important points" is given. The illustrations include a number of sketches and line drawings, besides some handsome half-tone engravings.

Throughout, the author shows keen appreciation of the salient engineering and other points of the works which he visited. His journey through this country was undertaken in 1913, but his account of the works visited was not published until last year. The volume is well worth adding to the irrigation section of any engineering library, both because of its concise descriptions of so many important irrigation works and also because it is as true in engineering and matters of governmental policy as in poetry that there are advantages in seeing ourselves as others see us.

Mill Construction

HEAVY-TIMBER MILL-CONSTRUCTION BUILDINGS. By C. E. Paul, Construction Engineer, Chicago. Chicago: Engineering Bureau, National Lumber Manufacturers Association. Paper; 6x9 in.; pp. 66; illustrated.

A broad and illuminating treatment of the mill-construction type of building is made available in this publication. The defining elements, arrangements of framing and best details of mill-constructed buildings are discussed and illustrated. There are a few tables at the end, but the value of the booklet lies mainly in the descriptive discussion of the several elements of the mill-construction type. The booklet covers this subject so well that it should be on the shelf of every engineer concerned with building construction.

The Shingle Roof Dangerous

SHINGLE ROOFS AS CONFLAGRATION SPREADERS: An Appeal to the Civil Authorities and Civic and Commercial Bodies. New York City: National Board of Fire Underwriters. Paper; 6x9 in.; pp. 21; illustrated.

The argument put forward in this pamphlet of fire-insurance interests is essentially that the shingle roof is the worst element in producing conflagrations. Views and brief descriptions of the principal conflagrations of recent years support the argument strongly, although little stress is laid on the large proportion of nonshingled values destroyed in these great fires or on the fact that many conflagrations started and spread in nonshingled districts. In any event the substance of the booklet provides a forcible argument for considering fire-resistant roofing and should have the careful study of every architect, every intending home builder and all who have to do with city building laws and fire laws.

To record "municipal progress in Minnesota" the League of Minnesota Municipalities has recently begun publishing a bulletin once in two months, to which has been given the name "Minnesota Municipalities." G. A. Gesell is editor and Prof. Frederick H. Bass is associate editor (publication office, Engineering Building, University of Minnesota; 25c. a copy or $1.25 a year). The first two numbers contain articles on "Central-Station Heating in Minnesota," "Virginia's New Sewage-Disposal Plant," "Public Water-Supplies" and other subjects.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

AMERICAN WOOD-PRESERVERS' ASSOCIATION: Proceedings of Annual Meeting Held at Chicago, Jan. 18-20, 1916—Baltimore, Md. (Mt. Royal Station): F. J. Angier, Secy.-Treas. Paper; 6x9 in.; pp. 432; illustrated.

ARTESIAN WELLS AND METHODS OF PUMPING THEM—By John D. Kilpatrick, Consulting Engineer, 30 Church St., New York City. [Reprinted from the Journal of the American Water-Works Association, Vol. 2, No. 4, December, 1915.] Paper; 6x9 in.; pp. 18.

BULLETINS, UNITED STATES DEPARTMENT OF LABOR—Washington, D. C. Paper; 6x9 in.; pp. 57 and 26, illustrated.
No. 339, Experiments on the Economical Use of Irrigation Water in Idaho—By Don H. Bark, Irrigation Engineer. No. 348, Relation of Mineral Composition and Rock Structure to the Physical Properties of Road Materials—By E. C. E. Lord, Petrographer. 10c. a copy, from Superintendent of Documents, Washington, D. C.

CANADIAN DEPARTMENT OF RAILWAYS AND CANALS—Ottawa, Ontario, Canada. Paper; 7x10 in.; illustrated.
Annual Report for Fiscal Year from Apr. 1, 1914, to Mar. 31, 1915. Pp. 456.
Railway Statistics for the Year Ended June 30, 1915. Pp. 190.
Canal Statistics for the Season of Navigation, 1915. Pp. 108.
Telephone Statistics for the Year Ended June 30, 1915. Pp. 83.

CANADIAN DEPARTMENT OF THE INTERIOR, IRRIGATION BRANCH—Ottawa, Ontario, Canada. Paper; 7x10 in.; illustrated.
Reports on Irrigation, 1915. Pp. 23.
Report on Irrigation Surveys and Inspections, 1915. Pp. 72.

CONCRETE CONSTRUCTION FOR RURAL COMMUNITIES—By Roy A. Seaton, Assoc. M. Am. Soc. M. E., Professor of Applied Mechanics and Machinery Design and Superintendent of Construction, Kansas State Agricultural College. New York: McGraw-Hill Book Co. [Agricultural Engineering Series.] Cloth; 6x9 in.; pp. xi + 223; 96 illustrations. $2 net.

EARTH PRESSURE, RETAINING WALLS AND BINS—By William Cain, M. Am. Soc. C. E., Professor of Mathematics, University of North Carolina. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. x + 287; 99 illustrations. $2.50 net.

ENGINEERING BULLETINS, MICHIGAN STATE BOARD OF HEALTH—Lansing Mich. Paper; 6x9 in.; pp. 68 and 15; illustrated.
No. 7, The Investigation into the Causes of the Typhoid Fever Epidemic at Monroe, Mich., Occurring During the Summer of 1915—By James W. Follin. No. 8, The Sanitary Privy—By Edward D. Rich, State Sanitary Engineer.

ENGLISH AND AMERICAN TOOL BUILDERS—By Joseph Wickham Roe, Assistant Professor of Machine Design, Sheffield Scientific School, Yale University. New Haven, Conn.: Yale University Press. Cloth; 7x10 in.; pp. xv + 315; 57 illustrations. $3 net.

FIVE-FIGURE MATHEMATICAL TABLES, Consisting of Logs and Cologs of Numbers from 1 to 40,000; Illogs (Antilogs) of Numbers from 0.0000 to 0.9999; Lologs (Logs of Logs) of Numbers from 0.00100 to 1.000; Illologs (Antilologs) of Numbers from 6.0 to 0.5000, Together with an Explanatory Introduction and Numerous Examples; also, Trigonometrical Functions and Their Logs of Angles from 0° to 90° at Intervals of 1 Minute, with Subsidiary Tables—Compiled by E. Chappell, B.Sc., A. C. G. I., Assoc. M. Inst. C. E., Temporary Naval Instructor R. N., Late Lecturer in Engineering at the City and Guilds' (Engineering) College, Imperial College of Science and Technology, London, S. W. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. xvi + 320. $2 net.

GLIMPSES OF OUR NATIONAL PARKS—By Robert Sterling Yard. Washington, D. C.: Department of the Interior. Paper; 6x9 in.; pp. 48; illustrated.

IMPRESSIONS OF AN ENGINEER IN PUBLIC SERVICE—By Morris Llewellyn Cooke, Director of Public Works of City of Philadelphia. [Presented before the Engineers' Club of Philadelphia, Nov. 16, 1915.] Paper; 6x9 in.; pp. 15.

THE INDUSTRIAL ARTS INDEX: Subject Index to a Selected List of Engineering and Trade Periodicals for 1915—Edited by Marion E. Potter, Louise D. Teich and Helen M. Craig. Third Annual Cumulation. White Plains, N. Y.: The H. W. Wilson Co. Cloth; 7x10 in.; pp. 509.

MOSQUITO CONTROL IN PANAMA: The Eradication of Malaria and Yellow Fever in Cuba and Panama—By Joseph A. LePrince, C.E., A.M., Chief Sanitary Inspector, Isthmian Canal Commission, 1904-1914, and A. J. Orenstein, M.D., Assistant Chief Sanitary Inspector, Isthmian Canal Commission. With an Introduction by L. O. Howard, LL.D., Entomologist and Chief, Bureau of Entomology, United States Department of Agriculture. New York: G. P. Putnam's Sons. Cloth; 6x9 in.; pp. xvii + 335; 100 illustrations. $2.50 net.

A NEW PENETRATION NEEDLE FOR USE IN TESTING BITUMINOUS MATERIALS—By Charles S. Reeve, Chemist, and Fred P. Pritchard, Assistant Chemist, Office of Public Roads and Rural Engineering. Washington, D. C.: Department of Agriculture. [Reprint from "Journal of Agricultural Research," Mar. 13, 1916.] Paper; 7x10 in.; pp. 6; illustrated.

OPINIONS AND DECISIONS OF THE RAILROAD COMMISSION OF WISCONSIN (Madison, Wis.), Volume XVI, Feb. 10, 1915, to Nov. 15, 1915—Compiled by Lewis E. Gettle, Secretary. Cloth; 6x9 in.; pp. 936.

PUBLICATIONS, UNITED STATES BUREAU OF MINES—Washington, D. C. Paper; 6x9 in.; pp. 60 and 30; illustrated.
Bulletin No. 91, Instruments for Recording Carbon Dioxide in Flue Gases—By J. F. Barkley and S. B. Flagg. 10c. a copy.
Technical Paper No. 113, Some Properties of the Water in Coal—By Horace C. Porter and O. C. Ralston. 5c. a copy.
Copies may be obtained from Superintendent of Documents, Washington, D. C.

PUBLICATIONS, UNITED STATES BUREAU OF STANDARDS—Washington, D. C. Paper, 7x10 in.; illustrated.
Report of the Tenth Annual Conference on Weights and Measures, Held in Washington, May 25-28, 1915. Pp. 254.
Circulars—No. 9, Testing of Glass Volumetric Apparatus. Pp. 32. No. 19, Standard Density and Volumetric Tables. Pp. 67. 10c. a copy.
Scientific Papers—No. 266, Preparation of Pure Iron and Iron-Carbon Alloys—By J. R. Cain, Associate Chemist; E. Schramm, Assistant Chemist, and H. E. Cleaves, Assistant Chemist. Pp. 26. No. 274, Interference Measurements of Wave Lengths in the Iron Spectrum—By Keivin Burns, Associate Physicist; W. F. Meggers, Laboratory Assistant, and Paul W. Merrill. Pp. 272. No. 275, Relation Between Composition and Density of Aqueous Solutions of Copper Sulphate and Sulphuric Acid—By H. D. Holler, Assistant Chemist, and E. L. Peffer, Laboratory Assistant. Pp. 9. Nos. 266 and 274, 10c. a copy; No. 275, 5c. a copy.
Copies may be obtained from Superintendent of Documents, Washington, D. C.

PUBLICATIONS, UNITED STATES GEOLOGICAL SURVEY—Washington, D. C. Paper; 6x9 in.; illustrated.
Bulletin No. 621-P, Analyses of Coal Samples from Various Parts of the United States—By Marius R. Campbell and Frank R. Clark. Pp. 251-375.
Water-Supply Papers—No. 332, Surface Water-Supply of the United States, 1912; Part XII, North Pacific Drainage Basins—By Nathan C. Grover, Chief Hydraulic Engineer; F. F. Henshaw, G. C. Baldwin and W. A. Lamb, District Engineers. Pp. 748. No. 383, Surface Water-Supply of the United States, 1914; Part III, Ohio River Basin—By Nathan C. Grover and Albert H. Horton and Warren E. Hall, District Engineers. Pp. 125. No. 369, Water Powers of the Cascade Range; Part III, Yakima River Basin—By Glen L. Parker and Frank B. Storey. Pp. 169. No. 398, Ground Water in San Joaquin Valley, California—By W. C. Mendenhall, R. B. Dole and Herman Stabler. Pp. 310.

PUBLIC SERVICE COMMISSION FOR THE FIRST DISTRICT OF THE STATE OF NEW YORK: Report for Year Ended Dec. 31, 1914. Vol. II, Statistics of Transportation Companies for Year Ended June 30, 1914—New York: Bureau of Statistics and Accounts of the Commission. Cloth; 6x9 in.; pp. 907.

RATE OF RETURN AND PROPER DISTRIBUTION OF REVENUE BETWEEN THE MUNICIPALITY AND THE PUBLIC—By C. B. Salmon, Beloit, Wis. [Paper Presented at Meeting of the Public Utilities Association of West Virginia at White Sulphur Springs, W. Va., Nov. 19, 1915.] Paper; 6x9 in.; pp. 30.

REPORT OF BRITISH DEPARTMENTAL COMMITTEE ON THE DANGER IN THE USE OF LEAD IN THE PAINTING OF BUILDINGS—Washington, D. C.: Bureau of Labor Statistics. Bulletin No. 188. Paper; 6x9 in.; pp. 207.

REPORT ON THE DESTRUCTIVE ACTION OF SEA WATER ON CONCRETE AND METHODS OF GUARDING AGAINST IT—By W. Watters Pagon, Assoc. M. Am. Soc. C. E. (With J. E. Greiner, Consulting Engineer, Fidelity Building, Baltimore, Md.) [Reprinted from the "Monthly Journal" of the Engineers' Club of Baltimore, April, 1916.] Paper; 8x11 in.

REPORT UPON THE PROTECTION OF THE PUBLIC HEALTH IN THE VALLEY OF THE NEPONSET RIVER—Boston, Mass. State Department of Health. Paper; 6x9 in.; pp. 75; illustrated.

RULES OF THE (INDIANA) STATE BOARD OF ACCOUNTS CONCERNING PUBLIC-BUILDING CONTRACTS, 1916—Indianapolis: The Board. Paper; 4x8 in.; pp. 12.

STATISTICAL ABSTRACT OF THE UNITED STATES, 1915—Washington, D. C.: Bureau of Foreign and Domestic Commerce. Cloth; 6x9 in.; pp. 749. Bound in paper 50c. a copy, from Superintendent of Documents.

THE STRANGE CASES OF MASON BRANT—By Nevil Monroe Hopkins. Philadelphia: J. B. Lippincott Co. Cloth; 5x8 in.; pp. 304; illustrated. $1.25 net.

STRESS AND STRAIN—By C. M. Broomall. [Reprinted from the Proceedings of the Delaware County Institute of Science, Media, Penn. Vol. VIII, No. 1, May, 1916.] Paper; 6x9 in.; pp. 18; 12 illustrations.

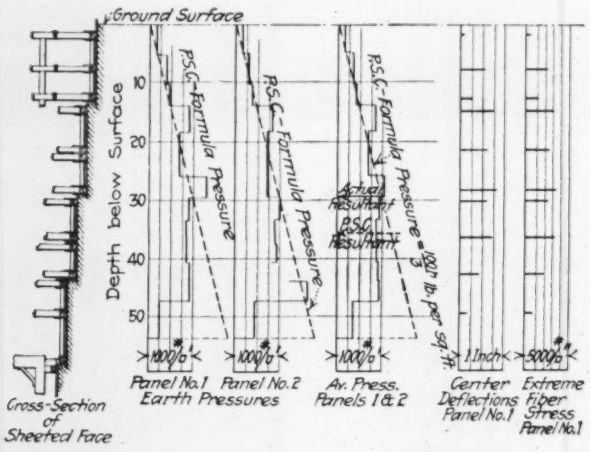
YEAR BOOK FOR 1910, ADMINISTRATIVE REPORT AND VARIOUS ECONOMIC AND GEOLOGICAL PAPERS—Urbana, Ill. (University of Illinois): Illinois State Geological Survey. Bulletin No. 20. Cloth; 6x9 in.; pp. 165; illustrated.

Field and Office

Tests Show Earth Pressures One-Half Hydrostatic

An excellent set of measurements of earth pressure against the sheeting of a deep trench was secured in the New York subway construction work recently. The tests were made at Prospect Park Plaza, Brooklyn, in a section being built by the Cranford Co. (John C. Sheridan, Chief Engineer), with maximum trench depth 80 ft. The trench side is held by wooden sheetpiling driven in five separate tiers. The pressure was measured by observing the deflections of the wales or rangers which lie along the sheeting and transmit its pressure to the transverse bracing struts.

The soil is glacial and consists of coarse sand with 20 to 30% clay, some gravel and occasional boulders.



EARTH PRESSURE AGAINST SUBWAY SHEETING; TESTS ON LENGTH OF 22 FT.

The fresh excavation face would stand as much as 12 ft. high and could be loosened and brought down only with the pick. Excavation was started 17 mo. before the observations were made, and in 11 mo. reached 60 ft. depth, later being carried down 20 ft. farther. Those connected with the tests consider that the earth had developed its full pressure when the observations were made.

The sheeting (3x10-in.) is 16 to 18 ft. long, with support by rangers (10x10 and 12x12) at ends and middle. The transverse braces are built-up 12x12's every 10 ft. longitudinally of the trench. Instead of trying to measure the deflection of a ranger on its full span, the observation was made on a shorter length, to eliminate local effects at the ends. On this fractional span a thread was stretched along the neutral axis, before the ranger was stressed, and later the offsets from this thread to five points on the inner face of the ranger were measured.

Specimen tests on the yellow pine composing the rangers showed the modulus of elasticity to average 1,500,000 lb. per sq.in. in bending. The modulus of rupture (of 1x1x15-in. specimens) ranged from 12,000 to 22,000 lb. per sq.in., which figures indicate that the actual extreme-fiber stresses of 2,000 to 3,000 lb. per sq.in. in the timbers are safe and justify the test method. By applying the modulus of elasticity to the observed deflections it was possible to compute the stresses in the timbers and hence their loads.

The results are given in the diagram reproduced herewith (from "Public Service Record," April, 1916, where Max Miller, Junior Engineer of the Public Service Commission, describes the tests and their results). The three broken-line diagrams in the middle show the pressures deduced for two adjoining panels of rangers and the average of the two. The maximum is around 1,000 lb. per sq.ft., which pressure prevailed from 25- to 47-ft. depth. Below 47 ft. a lower pressure was found.

Comparison with the Public Service Commission earth-pressure formula is afforded by the dash-line plot of the formula. The formula is

$$P = \frac{100h}{3}$$

which gives a trifle more than one-half hydrostatic pressure. The test results agree surprisingly well with the formula.

Mr. Miller points out that very many construction jobs afford opportunities for similar measurements. If such opportunities are utilized, much practical information on trench pressures can be accumulated in a short time.

Difficult Chimney Foundation Tested After Completion

A load test was recently made on a new chimney foundation of very original design in Pittsburgh. The test confirmed the engineers' judgment by showing that the foundation is amply safe under the intended loading.

In modernizing the boiler plant at the Brilliant pumping station, the city's Bureau of Water encountered a difficult problem in the design of foundations for two new steel chimneys 10x200 ft., since the soil is filled ground along the bank of the Allegheny River. Test borings showed that the subsoil fill consisted of well-compacted broken stone and shale mixed with red clay and a small quantity of gravel.

A test pit sunk to the level of the contemplated base of the foundation was loaded with a concentrated test load of 5,500 lb. per sq.ft. Immediately upon the complete application of this load a settlement of 0.028 ft. occurred in 20 min., at the end of which time movement ceased; the total settlement was 0.145. The soil at the elevation loaded consisted of well compacted soft shale, clay and small broken sandstone. It was concluded that a maximum load of 2½ tons per sq.ft. could be applied with safety.

Accordingly a mass-concrete spread footing unsupported by grillage was determined upon (Fig. 1). It is conical, with base area 730 sq.ft. and top area 346 sq.ft., the height being 13 ft. and the weight approximately 500 tons. The new stack comes directly over the

ite of the old stack, which was built with an ashlar foundation supported on timber grillage. The old base was removed to a point 1 ft. below the level of the bottom of the new foundation block, and clay placed between the top of the old base and the bottom of the new,

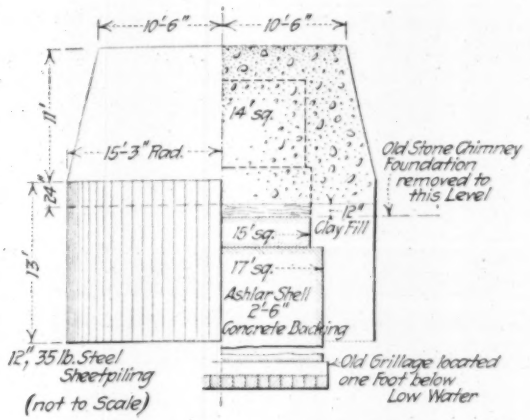


FIG. 1. SKETCH OF NEW STACK FOUNDATION AT BRILLIANT PUMPING STATION, PITTSBURGH

to prevent unequal distribution of the load over the bottom of the new block. As the elevation of the bottom of the foundation is below flood stage in the river a ring of steel sheetpiling was driven around the footing to a point 11 ft. below the base, to prevent scour due to fluctuation of water level.

The foundation block was poured as a monolith, without interruption of the work from start to finish.

The completed base was subjected to a loading of 1.6 tons per sq.ft. (including weight of base). This is about equal to the dead-load of the structure. A platform was built up, using four 15-in. I-beams 25 ft. long directly on the top of the foundation, crossing these with six 15-in. I-beams and three 12x14-in. timbers, and laying on this a floor about 25 ft. square. The materials used for loading consisted of 340 tons of dressed sandstone, available on the ground, and sufficient sacked gravel and cement to make the total load, together with 8 tons in grillage and platform, 680 tons, making a live-load of about 0.9 tons per sq.ft.

The load was applied uniformly over the entire platform. Levels were taken from time to time on the tops of four ¾-in. steel pins, one at each end of two 20-ft. diameters, 90° apart, whose elevation had been determined prior to the application of the load. They showed that an average settlement of 0.0055 ft. occurred during a lapse of five days, due to the weight of the completed foundation alone, which gave a pressure of 0.7 tons per sq.ft. By the time the test load was placed an average settlement of 0.028 ft. had occurred. An additional settlement of 0.004 ft. took place during the ensuing two days, making a total average settlement of 0.032 ft. under the full loading of 1.6 tons per sq.ft. Levels taken as the loading was removed showed no reaction.

The Brilliant station work is being done under the supervision of Charles A. Finley, Managing Engineer, Bureau of Water, and C. O. Daughaday, Division Superintendent, Mechanical Division.

Filling Trestles on an Electric Railway

The line of the Fort Dodge, Des Moines & Southern Ry., running north from Boone, Iowa, follows the valley of the Des Moines River, keeping high up on the slope and crossing numerous lateral ravines and gullies. In the original construction (as a steam railway) trestles were used over these ravines, but several of them have been filled since the line was converted to electric traction.

Pipe culverts provide the necessary drainage. In the smaller gullies, where clay pipe is used, a vertical riser pipe is placed at the upper end, so that mud and soil will settle around this and the comparatively clear water will flow into the culvert. The riser will be carried up as the gully fills.

Four trestles are now being filled at about four miles from Boone. These average 320 ft. in length and 75

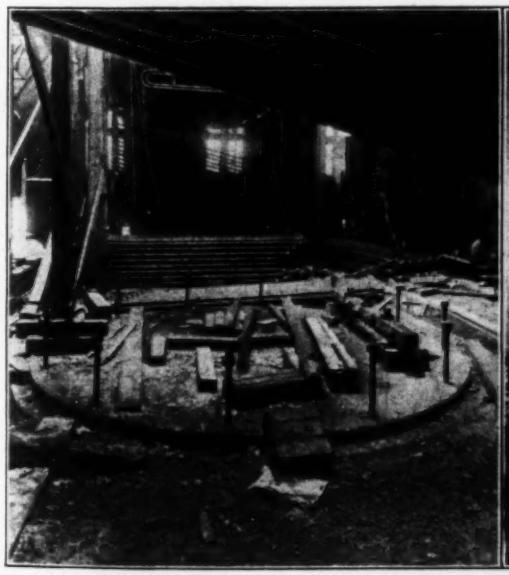


FIG. 2. ONE OF THE NEW CHIMNEY BASES AT BRILLIANT STATION

FIG. 3. TEST LOAD OF 680 TONS ON CHIMNEY BASE; ¾-IN. SETTLEMENT